MACHINERY.

March, 1908.

MAXIMUM STRESSES.—1.*

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THE problem of obtaining the maximum stress for which a part must be designed is sometimes a rather difficult matter. Often the designer arbitrarily assumes certain conditions to produce the maximum stress, which may be closely in accordance with the facts or may be far from them, depending entirely upon the judgment exercised.

Because of the time required to investigate, the extended operations necessary, men fully capable of performing the calculations, and often having a good understanding of the principles involved, sometimes make rash assumptions. In fact, there are many temptations to use a sort of combination of rough figures, judgment, and guess; satisfying the conscience by a wonderful faith in the factor of safety to cover a multitude of sins. It is often really necessary to pursue such a course in order to turn out the work with the expediency required by present-day employers. In some cases it is cheaper to be liberal with material than to virtually waste good time and brain fat on refinement of design. This is especially the case with the less important elements entering into a design. Too often, however, designs made with the foregoing ideas in mind are used over and over again, thus

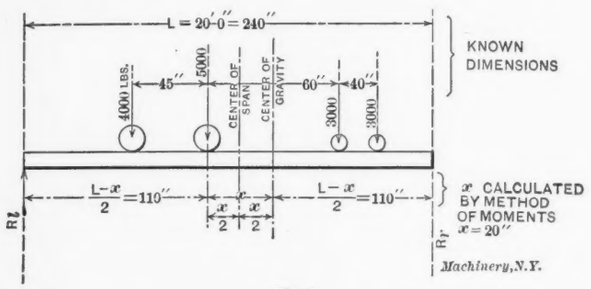

Fig. 1.

wasting material. The very specious argument: "It worked all right before," is frequently advanced in extenuation of duplicating bad design.

On the other hand, a part is almost as liable to be light as heavy, if the process of determining its size is a pure and simple guess. Such a case may, through failure, cost many times the amount necessary to have properly looked into the matter when making the design and to have provided reasonable security.

Purpose of Present Article.

It is the object of this article to present a few common cases of variable and of combined stresses, showing the manner of obtaining the maximum stress for which the part should be designed, these various cases leading up to the presentation of tables and diagrams, in data sheet form, whereby the labor of computing the stresses may be very much shortened.

Moving Loads.

The most common case of moving loads is that of two wheels equally loaded, such as a crane trolley on the crane bridge or the bridge upon the runway. There is nothing difficult about finding the maximum moment, provided the location of the load upon the span which produces the moment a maximum be known. This is also very simple, once the general rule covering the case is known. It is a fact, however, that many draftsmen, especially those engaged in mechanical work, do not know from positive knowledge what this location is. In many cases, they simply place the load in the center of the span or place one wheel in the center, and take it for granted that this location produces the maximum moment. If both locations be tried, the same moment will be found for each, which apparently confirms the supposition, and a man prone to jump at conclusions might readily draw the inference that the moment remains constant for any point intermediate between these two locations. Such is not the case.

General Rule.

For moving loads, when all the loads are upon the span at once, the maximum moment under any particular load will occur when the center of the span is midway between this load and the center of gravity of all the loads.

The load which produces the maximum moment will in nearly all cases be the heaviest one of the two loads adjoining the center of gravity, hence the rule may be stated:

Place the center of gravity of all the loads and the heaviest load adjacent to the center of gravity equidistant from the supports, and find the moment under the heaviest load.

Example.—What is the maximum moment produced by the system of wheel loading shown in Fig. 1?

Solution.—First find the center of gravity of all the loads by taking moments about some point of reference. Dividing the algebraic sum of the moments by the sum of the loads gives the distance from the point of reference to the center of gravity, thus:

Taking the 5,000-pound load as the point of reference,

Loads. Distances.		Moments.
5,000 × 0	=	000
3,000 × (+60)	=	+180,000
3,000 × (+100)	=	+300,000
4,000 × (—45)	=	—180,000

15,000 lbs. = total load. $\frac{300{,}000 = \text{moment}}{15{,}000} = 20$ inches,

distance of center of gravity to the right of the line of reference = x in Fig. 1.

Placing the load such that the center of the span is midway between the center of gravity and the heaviest wheel load, or what is the same thing, placing the load such that the center of gravity of all the loads and the heaviest load are equidistant from the supports, gives the locations as indicated at the bottom of Fig. 1. To find R_l and R_r take moments as follows: Since the center of gravity of all loads is now known, consider them concentrated at this point; then $R_l = \frac{15{,}000 \times 110}{240} = 6{,}875$ pounds and $R_r = \frac{15{,}000 \times 130}{240} =$ 8,125 pounds. Adding the two reactions as a check, 6,875 + 8,125 = 15,000 pounds = total load. Taking moments under the 5,000-pound load,

6,875 × 110	=	+756,250
4,000 × (—45)	=	—180,000

Maximum moment = 576,250 inch-pounds, the required answer.

Sections suitable for such purposes will be given in a later data sheet.

Two Wheels Equally Loaded.

The general rule previously stated, when applied to two wheels equally loaded, may be given as follows:

When the wheel-base is less than $(2 - \sqrt{2})$ *times the span* $(= 0.5858 \times \text{span})$ *the maximum moment occurs with both wheels on the span and when the distance from one support to the wheel nearest to it is equal to one-half the span minus one-fourth the wheel-base.*

When the wheel-base exceeds 0.5858 *times the span, the maximum moment occurs when one wheel is in the center of the span.*

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: Notes on Design, March and April, 1904; Charts in Designing, September, 1904; Flexure Simplified, December, 1903.

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The equations expressing the various relations between the quantities involved and the method of deducing formulas equivalent to the foregoing rules are given below:

Referring to Figs. 2a, 2b, and 2c,

Let W = total weight carried by the two wheels,

$W/2$ = weight on one wheel,

L = length of span,

B = wheel-base.

Consider the load to be moving from left to right; and

Let D_f = distance to front wheel from left support.

D_r = distance to rear wheel from left support,

M_{f1} = moment under front wheel with but one wheel on the span.

M_{f2} = moment under front wheel with both wheels on the span.

M_{r1} = moment under rear wheel with but one wheel on the span.

M_{r2} = moment under rear wheel with both wheels on the span.

Then,

$$M_{f1} = \frac{W D_f}{2 L} (L - D_f), \quad (1)$$

$$M_{r1} = \frac{W D_r}{2 L} (L - D_r) \quad (2)$$

$$M_{r2} = \frac{W}{L}\left(D_f - \frac{B}{2}\right)(L - D_f) \quad (3)$$

$$M_{r2} = \frac{W D_r}{L}\left(L - D_r - \frac{B}{2}\right) \quad (4)$$

To find what location of the load upon the span produces the maximum moment when both wheels are on, differentiate* equation 4, whence we get

$$D_r = \frac{L}{2} - \frac{B}{4} \quad (5)$$

which is the value of D_r which produces the maximum moment and agrees with the general principle previously stated.

To find the maximum moment, insert this value of D_r in equation 4 when it becomes, maximum

$$M_{r2} = \frac{W L}{4}\left(1 - \frac{B}{2 L}\right)^2 \quad (6)$$

For $B =$ or exceeds $\frac{1}{2}L$ and one wheel in the center of the span, the load on this wheel being $\frac{W}{2}$, the moment is $\frac{WL}{8}$.

Substituting this moment for M_{r2} in equation (6) thus:

$\frac{WL}{8} = \frac{WL}{4}\left(1 - \frac{B}{2L}\right)^2$ and solving for B,

$$B = (2 - \sqrt{2})\, L = 0.5858\, L \quad (7)$$

Equation (7) shows that when $B = 0.5858L$ the moment with one wheel in the center of the span is just equal to the maximum moment with both wheels on the span, consequently equation (6) does not apply for values of B greater than this.

Let M = the maximum bending moment,

Z = section modulus,

S_b = stress due to bending.

Then,

$$S_b = \frac{M}{Z}; \text{ or } Z = \frac{M}{S_b} \quad (8)$$

From this the maximum stress can be calculated when the section modulus is known, or the section modulus required to withstand a given moment and not exceed a specified stress may be determined.

It is interesting to note that for two wheels equally loaded, when the wheel-base equals or exceeds the span, the moment at any point of the beam is the same as for a uniformly distributed load, and that for wheel-bases equal to 0.5858 of the span or greater the maximum moment is the same as the maximum moment for a uniformly distributed load. For such cases, the beam required may be taken from the tables given in the various steel companies' hand-books by adding to the actual load a percentage to allow for impact, or by making the proper reduction in fiber stress. It follows from the above that, when the load is all carried on a single wheel, the moment at any point is double that for a uniformly distributed load. Hence, a beam may be picked out from the tables listed for double the load.

* $d M_{r2} = W\, d D_r - \frac{W}{L} 2 D_r\, d D_r - \frac{W B}{2 L} d D_r$. Placing $\frac{d M_{r2}}{d D_r} = 0$, and solving for D_r gives,

$$D_r = \frac{L}{2} - \frac{B}{4} \quad (5)$$

The Data Sheets.

Data Sheet No. 1.—The first part of data sheet No. 1 gives in condensed form the location for maximum moment, with formulas for same.

The second part gives a summary of the formulas for two wheels equally loaded, together with diagrams showing how

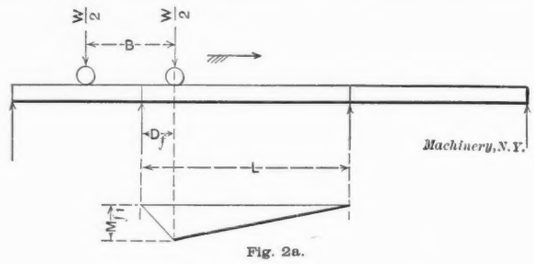

Fig. 2a.

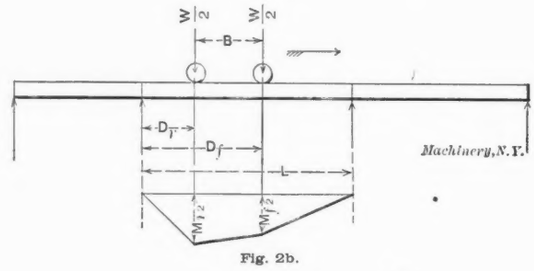

Fig. 2b.

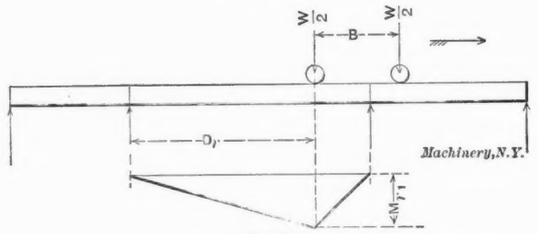

Fig. 2c.

the moment and shear varies for a specific location of the load or for any point of the beam.

The third part of sheet No. 1 will be discussed under its proper heading.

Data Sheet No. 2.—This sheet gives values of the variable V_m in the formula $M = WLV_m$, where M = the moment occurring at any point throughout the length of the beam, L = length of span, and W = the load. The lower table on this sheet gives values of the variable V_s in the formula $S = WV_s$ where S = the shear at any point of the beam and W = the load.

Data Sheet No. 3.—This sheet gives the same data as sheet No. 2, but in diagram form, which is easier to interpolate for intermediate values and will, therefore, recommend itself to those not prejudiced against diagrams. By the aid of these tables, or diagrams, the moment or shear at any point on the beam or girder can be quickly determined. This being known, it is easy to find the section modulus required, how close to the supports it may be necessary to bring the cover plates if a built-up section be used, and at what point the shear decreases sufficiently so that the web stiffeners may be omitted when such is permissible.

Example.—A girder of 20 feet span supports a load of 30,000 pounds carried on two wheels equally loaded, the wheel-base being 10 feet. (*a*) What is the maximum moment, and (*b*) what section modulus is required, assuming 12,000 pounds per square inch fiber stress?

Solution.—$L = 12 \times 20 = 240$ inches; $W = 30{,}000$ pounds; $B = 10$ feet $= 0.5L$. From the table (data sheet No. 2) or the diagram (data sheet No. 3) the maximum value of V_m is found to be 0.1406, say 0.14, then $M = WLV_m = 30{,}000 \times 240 \times 0.14 = 1{,}008{,}000$ inch-pounds. Ans. (*a*).

$$\text{By formula 8, } Z = \frac{M}{S_b} = \frac{1{,}008{,}000}{12{,}000} = 84. \quad \text{Ans. } (b).$$

Example.—A girder carries a moving load on two wheels equally loaded, the wheel-base being 0.2 of the span. At what point could the outside cover plate be stopped off if it constitutes one-third of the flange area?

Solution.—It could be stopped off at a point where the moment is two-thirds the value of the maximum moment. Referring to the diagram on sheet No. 3 the curve for $B = 0.2L$ shows the maximum value of V_m to be 0.2025. Two-thirds of $0.2025 = 0.135$. The same curve shows for $V_m = 0.135$ that $D =$ about $0.158L$, which is the required answer. If the girder were 40 feet long, the outside cover-plate could be stopped off at $0.158 \times 40 = 6.32$ feet from each end. The plate should be carried beyond the theoretic point for a distance sufficient to insert two or three rivets.

Example.—The wheel-base being 0.4 the span, what is the maximum shear?

Solution.—By referring to either the table or diagram, the maximum shear is found to be 0.8 of the load.

Example.—If, in the last example, the web of the girder will carry 0.6 of the load without stiffeners, how far from each end must stiffeners be provided?

Solution.—Referring to the shear diagram, it is found that for $B = 0.4L$ and $V_s = 0.6$; $D = 0.2L$, or stiffeners must be provided at each end for a distance equal to 0.2 of the span.

Moving Load and Oblique Reaction.

Often a beam carrying a moving load is supported at one end by a tie-rod or a strut making an acute angle with the beam. In the case of a strut, this produces a direct tensile stress in the beam in addition to the bending stress, and in the case of a tie-rod a direct compressive stress is induced. A familiar example of this latter is found in a jib crane as illustrated by Fig. 3.

Let the notation be the same as in the case of simple beams with moving loads, making the addition of dimension H and angle α as indicated in Fig. 3; then let T = thrust on beam caused by the angle of the reaction. (If a strut be used, this angle is measured from the bottom of the beam, and a pull instead of a thrust is the result.)

L = length of beam which is to be measured to the intersection of the center line of the rod with the center line of the beam.

α = angle of oblique reaction with beam,

A = cross-sectional area of beam,

S = direct stress,

S_b = stress due to bending.

Since the section modulus is based upon square inches, and stresses are expressed in pounds per square inch, all values should be expressed in inches and pounds.

The following formulas may then be developed:

$$T = \frac{W}{H}\left(D_r + \frac{B}{2}\right) \tag{9}$$

or,

$$T = \frac{W}{L}\left(D_r + \frac{B}{2}\right)\cot \alpha. \tag{9a}$$

$$S = \frac{T}{A} = \frac{W}{HA}\left(D_r + \frac{B}{2}\right) \tag{10}$$

or

$$S = \frac{T}{A} = \frac{W}{LA}\left(D_r + \frac{B}{2}\right)\cot \alpha \tag{10a}$$

$$M_{r2} = \frac{W D_r}{L}\left(L - D_r - \frac{B}{2}\right) \tag{11}$$

$$S_b = \frac{M_{r2}}{Z} = \frac{W D_r}{LZ}\left(L - D_r - \frac{B}{2}\right) \tag{12}$$

$$S + S_b = W\left(\frac{D_r + \frac{1}{2}B}{HA} + \frac{D_r\,(L - D_r - \frac{1}{2}B)}{LZ}\right) \tag{13}$$

or

$$S + S_b = \frac{W}{L}\left(\frac{(D_r + \frac{1}{2}B)\cot \alpha}{A} + \frac{D_r\,(L - D_r - \frac{1}{2}B)}{Z}\right) \tag{13a}$$

To find the value of D_r such that $S + S_b$ becomes a maximum, let $S + S_b = y$, substituting this in equation 13 and differentiating* gives

$$D_r = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4} \tag{14}$$

which is the value of D_r which gives the combined stress $S + S_b$ a maximum.

The first term of equation (14) may be considered to be made up of two factors, namely, $\frac{L}{2H}$ and $\frac{Z}{A}$. The first, $\frac{L}{2H}$, will, in practice, generally be approximately equal to unity; the second, $\frac{Z}{A}$, will be quite approximately equal to one-third the depth of beam when the section used is a single, light weight I-beam, which is the section most commonly used in constructions of this kind. Formula (14) may then, with sufficient accuracy for all practical purposes, be expressed thus:

$$D_r = \frac{L}{2} - \frac{B}{4} + \frac{1}{3}\text{ the depth of beam.} \tag{15}$$

Equation (13a), treated in a similar manner to that pursued in deriving formula (14), results in the expression

$$D_r = \frac{Z}{2A}\cot \alpha + \frac{L}{2} - \frac{B}{4} \tag{14a}$$

which is the value of D_r giving the maximum combined stress $S + S_b$ expressed in relation to the angle α.

If the direct compressive stress S is greater than the tensile stress due to bending, S_b, the entire cross sectional area of the beam is subjected to compression. In this case the member must be treated as a strut or column, the maximum stress being determined by formula (13) or (13a) by inserting the value of D_r as given by formula (14), (14a), or (15), whichever best suits the case in hand. The allowable stress may then be determined by any approved column formula. Gordon's formula seems to be the most popular, tables based upon it being given in all the large steel companies' handbooks.

It will be found, however, in practice, that the direct compressive stress is nearly always much less than the tensile stress produced by bending, hence the compression flange only is liable to buckle, and it would give too heavy a member to treat the entire section as a column. This leads to the consideration of

Beams Unsupported Laterally.

Let P = ultimate strength in pounds per square inch.

L = length unsupported laterally in inches.

r = radius of gyration in inches.

b = breadth of compression flange in inches.

Considering the compression flange of a beam as a rectangle,

$$r = \frac{b}{\sqrt{12}} \text{ and } r^2 = \frac{b^2}{12}.$$

Gordon's formula for columns is,

$$P = \frac{50{,}000}{1 + \frac{L^2}{36{,}000\,r^2}} \tag{16}$$

Inserting the value of r as given above in (16) gives,

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* $dy\,\frac{W}{HA}\,dD_r + \frac{W}{Z}\,dD_r - \frac{W}{LZ}\,2\,D_r\,dD_r - \frac{WB}{2LZ}\,dD_r.$

Placing $\frac{dy}{dD_r} = 0$ and solving for D_r gives

$$D_r = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4} \tag{14}$$

$$P = \frac{50{,}000}{1 + \frac{L^3}{3{,}000\,b^3}} \qquad (16a)$$

This is the ultimate unit stress provided the compression flange received no support from the parts in tension. The 1900 hand-book of the Pencoyd Iron Works (now American Bridge Co.) states: "Experiments have shown a reduction of about one-third of the normal modulus of rupture when the unsupported length becomes 80 times its flange width." But as the long beam may suffer if exposed to accidental cross strains, they recommend the greatest safe load to be reduced in such a ratio for long beams that when the length is 70 times the flange width, the greatest safe loads will be reduced one-half. This gives safe loads, corresponding to given lengths, as follows:

Length of Beam.	Proportion of Tabular Load forming Safe Load, or Ratio of Safe Compressive Stress to Safe Tensile Stress.
20 times the flange width	1 whole load
30 times the flange width	9/10 of load, or of tensile stress
40 times the flange width	8/10 of load, or of tensile stress
50 times the flange width	7/10 of load, or of tensile stress
60 times the flange width	6/10 of load, or of tensile stress
70 times the flange width	5/10 of load, or of tensile stress

The same table is given in the Carnegie Steel Co.'s handbook.

The Cambria Steel Co. gives the following formula,

$$S_c = \frac{18{,}000}{1 + \frac{L^2}{3{,}000\,b^2}} \qquad (17)$$

in which S_c = safe compressive stress when the safe tensile stress is 16,000 pounds per square inch. This formula is derived from Gordon's by making an allowance for a factor of safety and taking into account the fact that the compression flange receives some support from the parts in tension.

The diagram on data sheet No. 4 is based upon this formula,

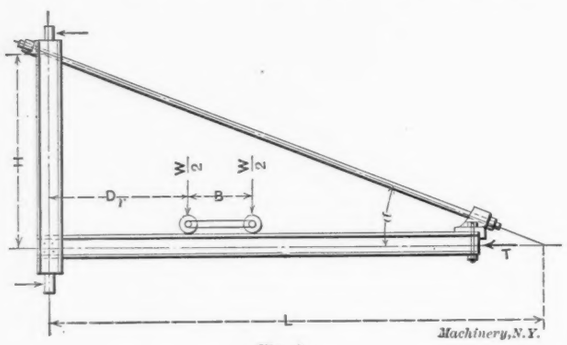

Fig. 3.

which seems more logical than the preceding table, and gives values on the side of safety. The curve giving safe compressive stresses for various ratios of $\frac{L}{b}$ corresponding to 16,000 pounds per square inch tensile stress was laid out from values calculated by the above formula. The curve for the lower allowable tensile stresses were reduced proportionally; thus, for 14,000 pounds tensile stress any value of $S_c = \frac{14{,}000}{16{,}000} = \frac{7}{8}$ of the value for 16,000 tensile stress.

From the foregoing it is seen that when applying formula (13) or (13a) the value of $S + S_c$ should not exceed the safe value of S_c as given by formula (17) and shown by the diagram on data sheet No. 4.

Example.—In a jib crane similar to Fig. 3, $W = 3{,}000$ pounds, $L = 10$ feet 0 inches, $= 120$ inches, $B = 24$ inches, $H = 60$ inches, the beam being a 6-inch, 12.25-pound I-beam, $Z = 7.3$ and $A = 3.61$ square inches. What is the maximum stress?

Solution.—By formula (14) the value of D_r for maximum stress is

$$D_r = \frac{L\,Z}{2\,H\,A} + \frac{L}{2} - \frac{B}{4} = \frac{120 \times 7.3}{2 \times 60 \times 3.61} + \frac{120}{2} - \frac{24}{4} = 56.023 \text{ ins.}$$

Inserting this value in equation (13),

$$S + S_c = 3000 \times \left(\frac{56\,023 + \frac{1}{2} \times 24}{60 \times 3.61} + \frac{56.023 \times (120 - 56.023 - \frac{1}{2} \times 24)}{120 \times 7.3} \right)$$

$= 10{,}900$ pounds per square inch approximately. This shows ample security until the fact that the compression flange is unsupported is taken into account. This flange is 3.33 inches wide, then $\frac{L}{b} = \frac{120}{3.33} = 36$, and referring to data sheet No. 4 it is seen that for this value of $\frac{L}{b}$ and $S_c = 10{,}900$, the corresponding tensile stress is about 14,000, which shows that there is not the security which at first seemed apparent.

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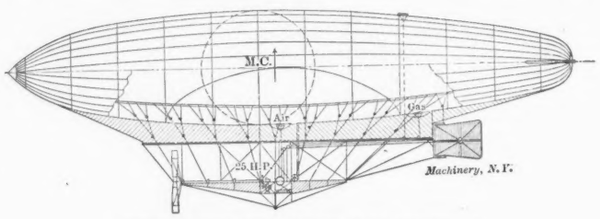
THE ARRIVAL OF THE FLYING MACHINE AS A COMMERCIAL PRODUCT.

We received the other day what is, so far as we know, the first catalogue of a flying machine manufacturer, building a line of standard machines. We are not quite sure from the information given that the maker carries his product in stock, but the designs are evidently standardized and are adapted to building in large quantities.

The circular referred to is that of Louis Godard, of Saint-Ouen, France. Two examples of flying machines are shown.



"Yacht Aerien de Plaisance et de Tourisme."

One of them is the "1907 Model, Destroyer Type." It is stated that this can attain a speed of from 31 to 34 miles per hour. It has a gas bag 215 feet long and 38 feet maximum diameter, approximating a symmetrical cucumber in shape, though somewhat pointed at the leading end. Two motors of 70 horse-power each drive the two screws, one at the front and the other at the rear of the operator's platform. These motors are said to weigh about 6½ pounds per horse-power. The entire apparatus weighs about 6,150 pounds. With passengers and supplies on board, including fuel for ten hours ("essence for ten hours' march," literally), cooling water, seven passengers in all (a pilot, his assistant, two "mecaniciens" and three "invites") and a supply of food, the total weight is 9,200 pounds.

The other standard machine, of which we show a cut, is called a "Yacht Aerien de Plaisance et de Tourisme,"—which the reader can translate to suit himself. This is considerably smaller, being only about 130 feet long, and with a 30 horse-power motor which is capable of giving the machine a speed of 20 miles per hour, or thereabouts. It is hoped that this will suit the needs of sportsmen and aerostatic amateurs. It is also suited for military use in the instruction of "sky pilots," and in scouting work in colonies and other rough countries.

It begins to look as if the flying machine had arrived.

* * *

According to *Page's Weekly*, some experiments have recently been made on the Egyptian State railways, with regard to the heating of locomotive feed water. It is stated that the use of a heating apparatus for this purpose has effected a saving of 21.4 per cent in the coal consumption. The water is heated by the exhaust steam. It is claimed that the feed water heating apparatus saves its own cost in a year, allowance being made for depreciation.

* * *

A new recently completed mountain railway, built up the Wetterhorn in Switzerland, has a rise of about 1,500 feet in a distance of 2,000 feet, which is a "grade" of 75 per cent. On account of being so steep, the railroad is commonly referred to as the "elevator."

GEAR-CUTTING MACHINERY.—3.

RALPH E. FLANDERS.*

This installment of the series of articles on gear-cutting machinery describes the application of the molding-generating principle to the cutting of spur gears.

In the molding-generating method the processes which have been found most practical are planing or shaping, milling, and to a very limited extent, grinding or abrasion. For spur gears, so far as the writer knows, no use has been made of the impression process; it would be as practicable as in the case of bevel gears, of which an example will be shown in a succeeding issue, but there is no need for trying it. In the shaping process the commercial use of the molding-generating idea is confined largely to one machine, which has found a very extended application. In the milling process, there has been a wonderful development in the past few years, which

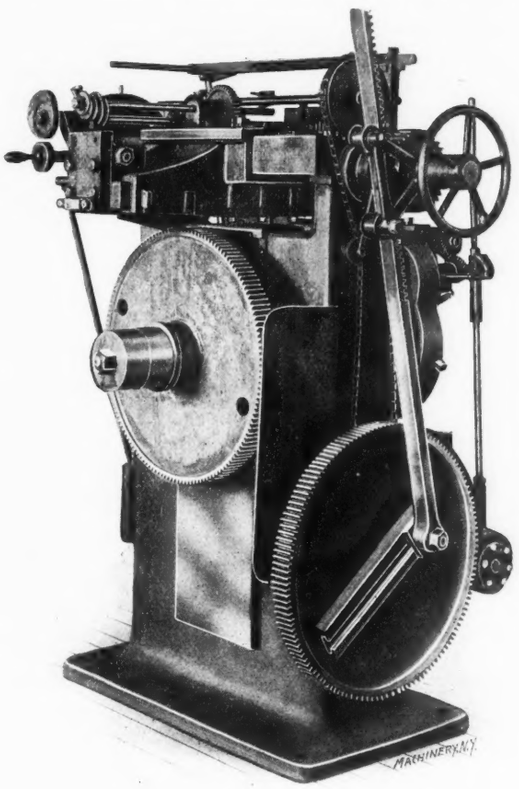


Fig. 48. The Bilgram Automatic Spur Gear Machine, using a Shaper Tool shaped like a Rack Tooth.

is witnessed to by the large number of machines we are able to show involving this operation. But one example can be given of the use of grinding.

Molding-Generating Machines Working by Shaper Action.

In Fig. 48 is shown an automatic spur gear cutting machine made by Hugo Bilgram, Philadelphia, Pa., and in use in his plant. The tool acts as a rack tooth, and generates the gear teeth in accordance with the principle of Fig. 8. Instead, however, of finishing one tooth space complete and then indexing to the next one, the operation is continuous. As has been explained, in the molding process the blank and tool must be rolled on each other as if the former were a gear meshing with a rack, of which the latter represents a tooth. In the Bilgram machine, instead of having this rolling action take place for each tooth, it takes place but once in the completion of the gear. The tool starts in at one side of the blank, being given a motion similar to that given by a shaper. It cuts its first stroke in the work, which is thereupon indexed for the tool to take a second cut in the next tooth. This indexing proceeds with every stroke of the shaper ram so that the teeth are all formed together. Besides the rotation of the blank due to the indexing, there is imposed on this that which we have described as being necessary for the rolling motion. For this, the blank is uniformly rotated, and the ram carrying the tool is fed along sideways to agree with the motion of the imaginary rack. These various movements are all attended to by change gearing. It will be seen that with this machine, as with others of the molding-generating type, but a single tool is needed for a given pitch. This may be used to cut any gear, from the smallest to the largest. This machine

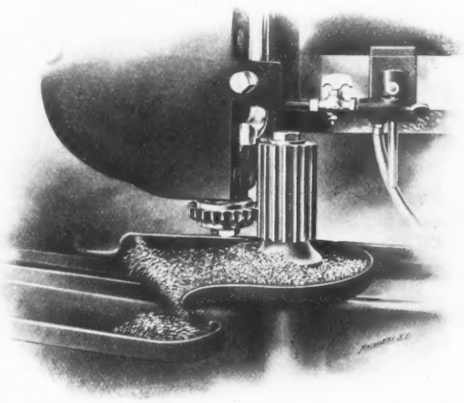


Fig. 49. Detailed View of the Action of the Fellows Gear Shaper; see also Fig. 63.

is unusually interesting in its mechanical movements, and it is unfortunate that we have not the space here to go into its details more thoroughly.

The other machine we show of the molding-generating type involving the shaping process is one widely used, built by the Fellows Gear Shaper Co., of Springfield, Vt.* One of these machines is shown later in Fig. 63, engaged in cutting an internal gear, while in Fig. 49 is a nearer view which shows the action of the cutter in forming the teeth of a long spur pinion. The principle by which it operates is exactly that shown in Fig. 6. The cutter is a gear having the outline of a member of the interchangeable series to which the gear to be cut belongs. It and the blank are rotated together in the proper ratio. The cutter is first fed in to full depth and

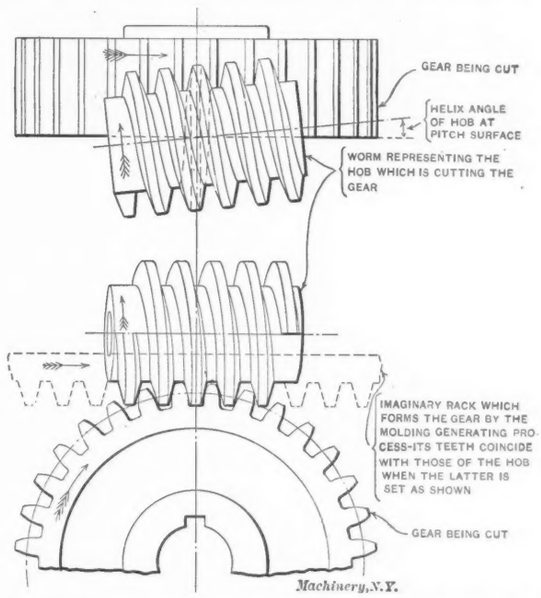

GEAR BEING CUT
HELIX ANGLE OF HOB AT PITCH SURFACE
WORM REPRESENTING THE HOB WHICH IS CUTTING THE GEAR
IMAGINARY RACK WHICH FORMS THE GEAR BY THE MOLDING GENERATING PROCESS-ITS TEETH COINCIDE WITH THOSE OF THE HOB WHEN THE LATTER IS SET AS SHOWN
GEAR BEING CUT
Machinery, N.Y.

Fig. 50. Diagram illustrating the Principle of the Hobbing Process of Forming Spur Gears.

then the rotation is started and continued until the full periphery of the work has been formed. It is understood, of course, that the cutter is given a vertical shaping movement by the ram to which it is attached. The proper ratio between the cutter and the blank is obtained by change gears set for the number of teeth it is desired to have in the gear. The

* Associate Editor of MACHINERY.

* Previously described in MACHINERY in articles entitled "A Gear Shaper," January, 1898, and "Gear Shaper Improvements," February, 1900.

movements of the machine are automatic, in that when it has been set for the pitch of cutter and number of teeth, the machine will automatically feed itself to depth, stop this feeding and commence the slow rotary movement, continuing this until the work is completed, when the machine will stop. In the case of gears which have to be very accurately cut in refractory materials, provision is made for automatically taking a second cut around at a slightly increased depth, so as to give assurance that the form of the tooth is as true as can be obtained. There are many interesting phenomena connected with this method of gear cutting which cannot be entered into here. A study of it will serve as well as anything we know to introduce a student to the principles underlying the science of providing gears with suitable tooth outlines.

The Molding-Generating Milling or Hobbing Machine.

The most widely used process involving the milling operation of molding-generating is the hobbing process. The principle of this method is shown diagrammatically in Fig. 50. Here we have an imaginary rack meshing with a gear, and molding its teeth in the same way as in Figs. 7 to 10. The teeth of this rack, shown in dotted outline, coincide with the outlines of a hob, shown in full lines, which has been set at such an angle as to make the teeth on its front side parallel with the axis of the gear. In other words, it has been set at the angle of its helix, measured at the pitch line. It will be seen that the teeth of the hob, when set in this position, correspond with the teeth of the rack. If, now, the hob and blank be rotated at the ratio required by the number of threads in the hob and the number of teeth in the gear, this movement will cause the teeth of the hob to travel lengthwise in exactly the same way as the teeth of the imaginary rack would travel, if in mesh with the gear whose teeth are to be cut. It will thus be seen that the hob fulfills the requirements necessary for molding the teeth of the gear to the proper form. In practice the hob is rotated in the required

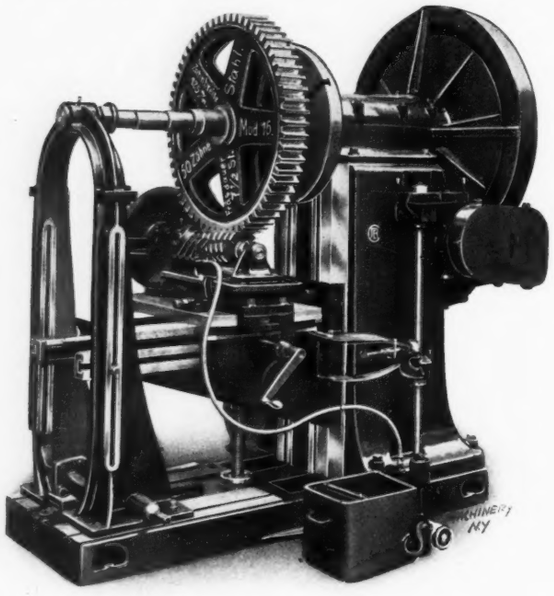


Fig. 51. The Reinecker Spur Gear Hobbing Machine.

ratio with the work, and fed gradually through it from one side of the face to the other. When it has passed through once, the work is completed.

Of the great number of machines built during the past few years involving this principle, many are arranged for cutting spiral gears as well as spur gears. In describing these tools part of them have been classed as spur gear cutting machines, while the remainder will be found under machinery for cutting spiral gears. Of course, all of the machines in the latter division are capable of cutting spur gears also, and in referring to machines for cutting spur gears they should be classed with those described in the following paragraphs. Some of the machines illustrated in Figs. 51 to 57 can be used for cutting spiral gears as well, but have been described in this section because the engravings we have at our disposal show them arranged for cutting spur gears.

The spiral gear-hobbing machine bears about the same relation to the plain spur gear hobbing machine that the universal does to the plain milling machine. The added adjustments and mechanism required in each case tend to somewhat limit the capacity of the machine in taking heavy cuts,

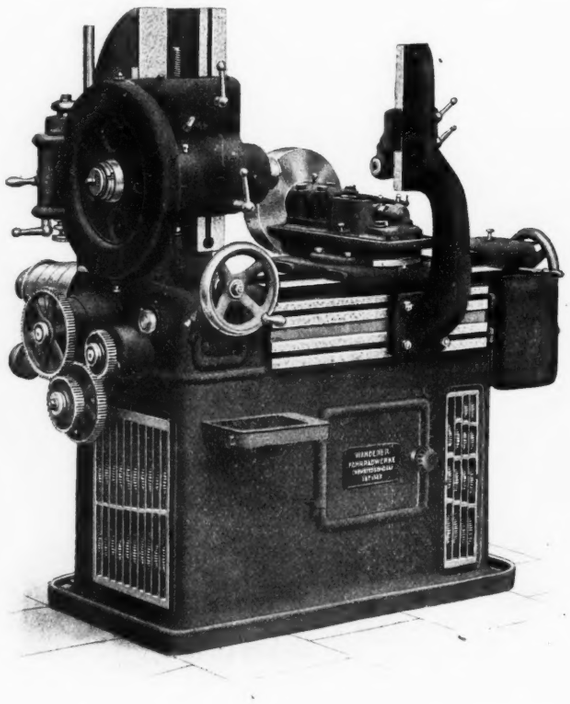


Fig. 52. The Wanderer Spur Gear Hobbing Machine.

though they add to its usefulness by extending the range of work it is capable of performing. The requirements of the successful gear hobbing machine are:

First. A frame and mechanism of great rigidity.

Second. Durable and powerful driving mechanism.

Third. Accurate indexing mechanism.

The first requirement is one of great importance, not only in its influence on the heaviness of the cut to be taken and the consequent output of work, but on the matter of accuracy as well. The connection between the hob and the work, through the shafts and gearing, is liable to be so complicated that the irregular cutting action of the hob produces torsional deflections in the connecting parts, leading to serious displacement from the desired relation between the hob and the teeth being cut. This displacement from the desired position results in teeth of inaccurate shape, weak and noisy at high speeds.

In its effect on the output, rigidity is even more important in the hobbing machine than in the orthodox automatic gear cutter. A heavier cut is taken, since a greater number of teeth are cutting on the work at once. The number of joints between the cutter and the work-supporting table and spindle, must therefore be reduced to a minimum, and the matter of overhang both for the work and the cutter must be carefully looked out for. The reduction of overhang is hampered at the cutter head by the necessity for a strong drive and an angular adjustment. In the case of the work-supporting parts, it is difficult to bring the cutting point close to the bearing on account of the necessity for plenty of clearance below the work for the hob and its driving gear to run out into.

The matter of design of the driving mechanism for the hob and the work is a difficult one. Not only must it be rigid for the sake of accuracy, as previously explained, but careful attention must be given to durability as well. It requires great skill to design a durable mechanism for the purpose within the limitations imposed—in the cutter head by the

necessity for reducing the overhang, and in the work table by the high speed required for cutting small gears.

Since the indexing wheel works constantly and under considerable load, it and the worm must be built of such materials as will preserve their accuracy after long continued use. Particular attention should be given to the homogeneity of the material of the index worm-wheel, to make sure that it does not wear faster on one side than on the other.

The field of the hobbing process for cutting spur gears has not yet been definitely determined. In some work it appears to have certain advantages over the usual type of automatic gear-cutting machine, while in other cases it falls behind. It will doubtless require continued use, with a variety of work, and for a considerable length of time, to determine just what cases are best suited for the hobbing machine, and what for the machine with the rotating disk cutter. It is not probable that in the future either of them will occupy the field to the exclusion of the other.

Examples of Spur Gear Hobbing Machines.

The first gear hobbing machine we show (see Fig. 51), is built by J. E. Reinecker of Chemnitz-Gablenz, Germany. This builder was one of the first to make a commercial success of the hobbing process, having applied it several years ago in his "Universal" gear-cutting machine. The tool we show is a specialized form of that universal machine, adapted particularly to the hobbing of spur gears. As may be seen, in form the machine is derived from the standard milling machine, bearing about the same relation to it that the Becker-Brainard gear-cutter in Fig. 20 does. The spindle is mounted on what corresponds to the carriage of the milling machine, which may be swiveled so as to bring the teeth of the hob on the upper surface parallel to the work spindle. The spindle is driven by an internal gear of large diameter. The work spindle is driven from the rear of the column by the index worm-wheel, which is connected with the cutter spindle through change gears (shown at the left of the picture) and the splined shafts and bevel gear connections. The knee of the machine having been raised so that the cutter is set at the proper height to cut teeth of the desired depth, and

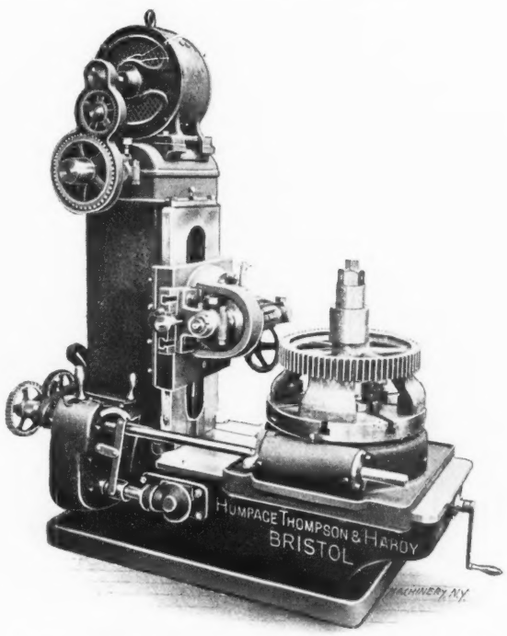


Fig. 53. An Electrically-driven Gear Hobbing Machine built by Humpage, Thompson & Hardy.

the machine being started, with hob and gear blank rotating in the proper ratio, the table with the hob is fed in along the knee toward the column of the machine, cutting the teeth in the wheel as it does so, the operation being completed when the hob has made one pass through the work. It will be noted that the work arbor, the knee and the base of the machine are all very firmly tied together by a rigid brace, which may be adjusted to suit different conditions of diameter and length of work.

Another machine, built by the Wanderer Works, formerly Winklhofer & Jaenicke, Ltd., Schoenau, near Chemnitz, Germany, is shown in Fig. 52. It is of the same type, so far as the frame work is concerned, as a regular automatic machine, it being almost identical in its lines with those shown in Figs. 21 to 28, inclusive. The differences in mechanism, of course, are those due to the necessity for connecting the work spindle and the cutter by change gearing to give the proper ratio, and for setting the spindle, as well, at the proper angle to agree

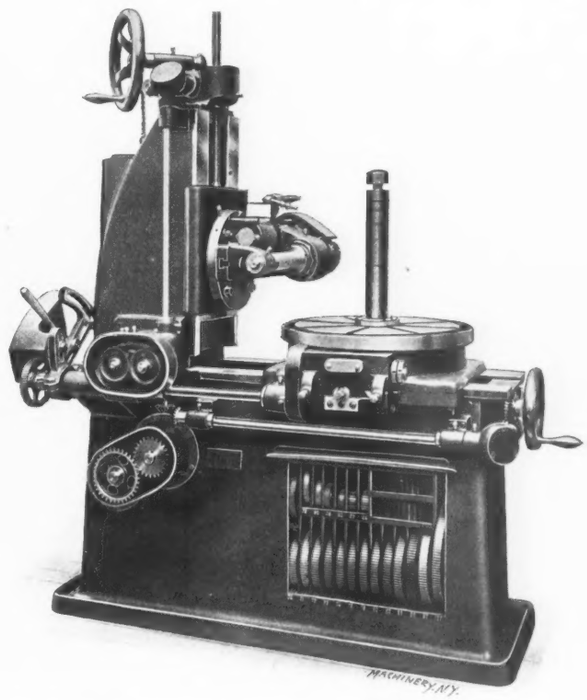


Fig. 54. The "Rhenania" or "Burton" Spur Gear Hobbing Machine.

with the helix angle of the hob. The feed, also, is continuously forward until the work is completed, instead of having a quick return for each tooth cut. It is readily seen that this rearrangement means, on the whole, a somewhat simpler machine in the case of the hobbing machine than for the automatic gear-cutter, particularly since intermittent indexing is avoided. The cutter spindle is driven by an internal gear of large diameter.

The orthodox type of spur gear hobbing machine differs from the examples we have just described in the position of the spindles. In this case the cutter spindle is mounted in a slide on the column, while the work is carried on the bed, being adjusted in or out on it according to its diameter. In its general arrangement it bears a strong resemblance to the standard type of formed cutter machine for heavy work as illustrated in Figs. 30 to 36.

In Fig. 53 is the first example we show of this type, a machine built by Humpage, Thompson & Hardy, of Bristol, England. It appears to be of unusually heavy construction. The machine as shown is entirely self-contained, a motor being mounted on top of the column. It can be made either motor or belt driven without other alteration than the removal of the motor and gears and the substitution of a pulley, or *vice versa*. The drive is of the constant speed type, the speed changes being obtained through gearing, running constantly in a bath of oil. The machine is provided with an unusually ingenious feed mechanism. A pair of taper pulleys, carrying a light belt, is used as a primary means of changing the feed. This operates, however, through the medium of an epicyclic gear arrangement through which most of the strain of transmission is taken. The cutter slide is over-balanced, so that it has to be fed against the pull of the counterweight, thus taking up all back lash.

The manufacturers call attention to the results of tests made on their machines; 2½-pitch gears in cast iron have been cut at the rate of 4 inches of tooth length per minute; 3-pitch gears of the same material at 5.9 inches per minute,

while the same style teeth in mild steel have been cut at 4 inches per minute. The size shown will cut work 23 inches in diameter by 13½ inches face.

The machine shown in Fig. 54 is sold on the continent by Alfred Schütte, and there known as the "Rhenania." In England it is sold by Burton Griffiths & Co. and called the "Burton." This is one of the machines which can be furnished for cutting spiral gears if desired, though in the form

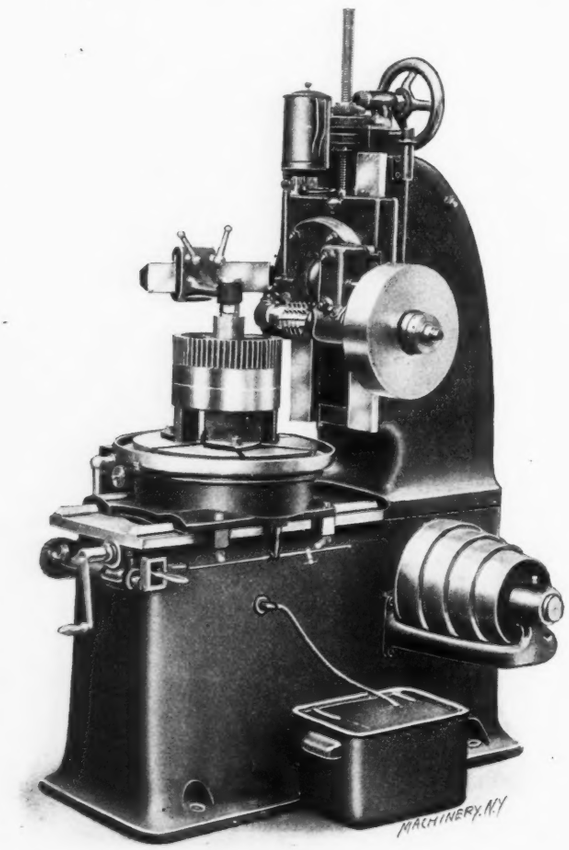


Fig. 55. A Continental Gear Hobbing Machine, sold by Selig, Sonnenthal & Co.

shown it is adapted for spur gears only. The spindle of this machine is driven somewhat differently from the previous ones shown. A worm connected at its inner end by bevel gears to the vertical power transmission shaft, and located on the axis of the angular adjustment, drives a worm-wheel on the short shaft mounted above and to the rear of the cutter. Spur gears connect this short shaft with the spindle. This arrangement reduces the overhang of the cutter slide. The work table may be revolved freely in setting the work by withdrawing the index worm, this being mounted on a dovetail slide, which is withdrawn or inserted again by operating the square head collar screw shown. Adjustable stops limiting this motion determine its adjustment, which may be altered to compensate for wear. The worm is of hardened steel, ground all over after hardening. The work spindle may be supported, when necessary, by a stiff outboard bearing on an arm which is fastened to the back of the table and the back of the bed, tying the work, work table and bed rigidly together.

Another machine of German origin, made by the Schubert & Salzer Maschinenfabrik, of Chemnitz, and sold by Selig, Sonnenthal & Co., of London, England, is shown in Fig. 55. This machine, like the one shown in Fig. 52, has the spindle driven by an internal gear. To allow this to be made of unusually large diameter and still bring the hob as close to the face of the column as possible, so as to give a rigid construction, the hob is carried below the axis around which the swiveled head is adjusted, instead of centrally with it, as is usually the case. This limits the adjustment to the comparatively slight angle required for spur gears, but it would seem to greatly increase the stiffness of the construction and the power of the drive. As may be seen, the outboard support for the work arbor is of unusual design, consisting of an arm bolted to the side of the column, carrying a slide which may be adjusted in or out to suit the position of the work table.

The machine shown in Fig. 56 is built by Henry Wallwork & Co., Ltd., Manchester, England, and sold by Alfred Herbert, Ltd., Coventry, England. A number of interesting features will be noted in this machine. The spindle drive, for instance, is unusual. A train of spur gears connects the shaft on the axis of the swiveling adjustment with a short vertical shaft which drives the cutter arbor by worm or spiral gearing. The work support consists of a triangular arm supported by two vertical posts, the outer end of the arm having a bushing for the work arbor. One of the vertical posts is longer than the other, and the arm may be raised from the shorter one and swiveled about the longer one when removing or replacing the work. Since this support always travels with the table it does not have to be adjusted when adjustments are made in the position of the latter. The table has a large annular bearing, with an extended shank having a tail bearing fitted with lock nuts to prevent lifting. The chip pan is solid with the slide and does not rotate with the table as in some of the other machines.

The machine shown in Fig. 57 (Sir W. G. Armstrong, Whitworth & Co., Ltd., Manchester, England,) belongs with the machines just described, but is differentiated from them by the fact that the column carrying the spindle is adjusted on the bed for the diameter of the work, instead of having the work table adjustable. In this respect it resembles the gear cutter shown in Figs. 37, 38 and 39. Since the work spindle is stationary, the index wheel is placed below the bed. The spindle drive is through spur and bevel gears from the vertical shaft alongside the column. This machine is so large that special provision is made for handling most of the movements, there being a power elevating device for the spindle head, and a power traverse of the head on the bed. As shown, also, the spindle head is swiveled by a worm meshing with worm-wheel teeth cut on a portion of the periphery of the sector.

An ingenious hobbing machine built a number of years ago by Warner & Swasey Co., Cleveland, Ohio, has been illustrated in our columns.* Instead of using a worm-shaped hob, the hob was formed with parallel circular teeth, but made in two halves which were shifted endwise with relation to each other by a cam mechanism. This split hob and the blank were geared together in the proper ratio and rotated together

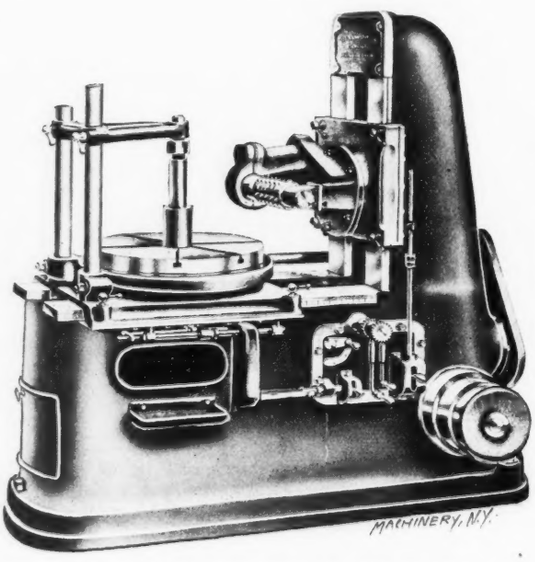


Fig. 56. The Wallwork Gear Hobbing Machine.

the same as in other hobbing machines. The half of the hob which was cutting was fed forward axially to correspond with the rack movement required by the rotation of this blank. When that half had left the cut, it was brought back by a cam movement, ready to start in again on its forward

* See article entitled "American Gear Cutting Machinery" in the June, 1898, issue of MACHINERY.

axial movement as soon as it again reached the cutting position. The other half of the hob was similarly controlled, the parts thus sliding in and out with each other alternately.

As previously explained, this list does not include all the machines of the hobbing type adapted to cutting spur gears.

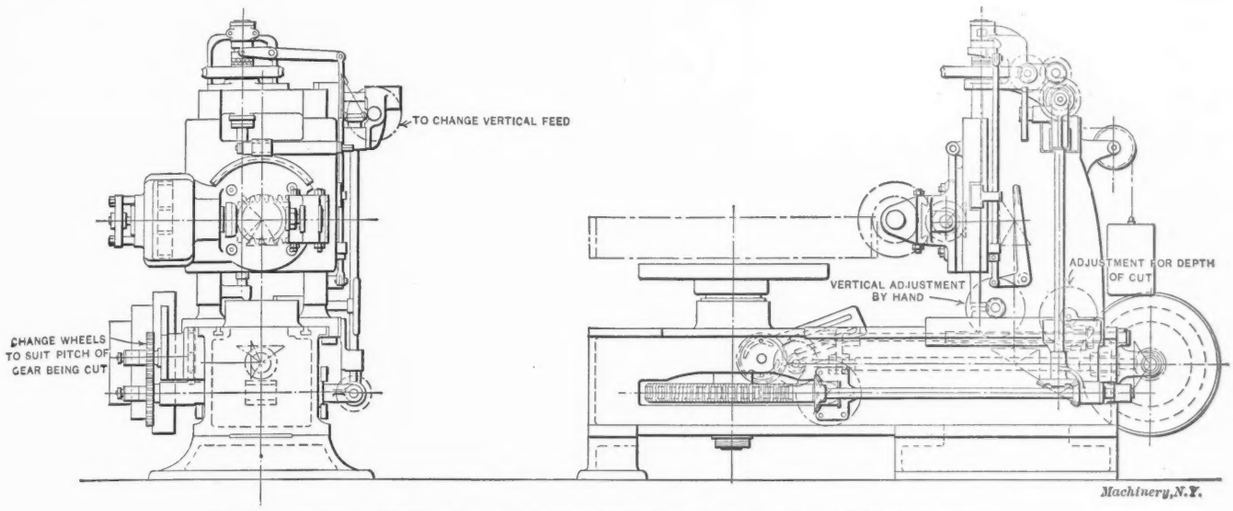

TO CHANGE VERTICAL FEED
CHANGE WHEELS TO SUIT PITCH OF GEAR BEING CUT
VERTICAL ADJUSTMENT BY HAND
ADJUSTMENT FOR DEPTH OF CUT
Machinery,N.Y.

Fig. 57. Armstrong Whitworth & Co.'s 6-foot Hobbing Machine, with Column adjustable for Diameter.

Those described under the heading of spiral gear cutting machines, found in a succeeding installment of this article, include examples by the following makers: Biernatzki & Co., Chemnitz, Germany; Gould & Eberhardt, Newark, N. J.; Grant Lees Machine Co., Cleveland, Ohio; John Holroyd & Co., Milnrow, England; Maschinenfabrik Lorenz, Ettlingen, Germany; Newton Machine Tool Works, Philadelphia, Pa., and Schuchardt & Schutte, Cologne, Germany. It will be seen that this list is quite an imposing one, including fourteen manufacturers of machines of this type. With the exception of the Reinecker machine, which dates from an earlier time, all of these were designed within the past few years, most of them to meet the demand for gear-cutting machinery created by the automobile trade.

The Grinding or Abrasion Operation, applied to the Molding-Generating Process.

One application of the molding-generating process involving the grinding operation, uses the rack tooth principle in a manner exactly identical with that shown in Fig. 10, in forming the cutters used with the Fellows system of gear tooth shaping. A special machine is provided, carrying an emery wheel with a plane face which can be constantly kept straight by means of a diamond truing device incorporated in the machine itself. The hardened gear-cutter, which has been cut to leave but a few thousandths of metal to finish on the sides of the teeth, is placed in the machine and rolled

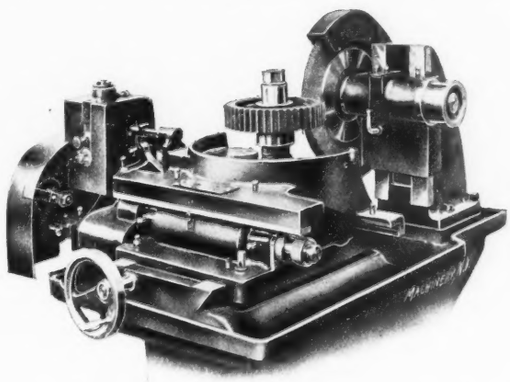


Fig. 58. Another View of the Machine shown in Fig. 59.

past the face of the emery wheel under the restraint of metallic tapes in a way that is identical with that shown in Fig. 10.

An application of this principle to the finishing of the teeth of hardened gears is shown in Figs. 58 and 59. This machine trues the teeth of hardened gears used in automobile construction. The principle of its action is also the same as in Fig. 10, though carried out in a somewhat different way than in the case of the Fellows cutter grinding machine just mentioned. In this case, the emery wheel has its outline beveled to the shape of the rack tooth, using for this purpose both sides of the wheel, which has an outline more nearly resembling the shaper tool T_1 in Fig. 8, than the grinding wheel of Fig. 10. Attachments permanently set to the proper angle (14½, 15 degrees or any other angle desired) are provided, by means of which the operator can almost instantly bring the wheel to the proper shape whenever it shows signs of losing it. The emery wheel has a continuous vertical reciprocating movement, great enough to cover the whole face of the wheel. It will be seen that it is thus made to cover the whole surface of the rack tooth which it represents in the molding-generating process.

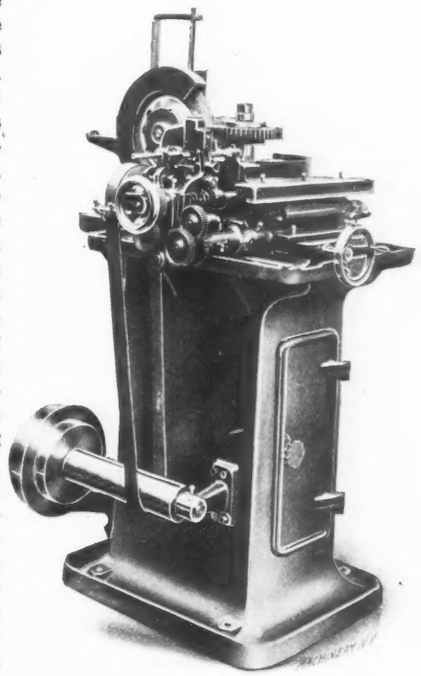


Fig. 59. A Machine for Grinding the Teeth of Gears to Accurate Shape after Hardening.

The hardened gear to be operated on, previously cut to leave a few thousandths for finishing, is mounted on the vertical work arbor on the table as shown. By suitable change gears and controlling mechanism, this slide is made to travel across the face of the wheel while the work is rotated at the same time, in such a ratio as to give the identical movement that would result from rolling the wheel on the imaginary rack, a tooth of which is represented by the outline of the emery wheel. The work starts in at one side of the wheel, out of contact with it, rolls into it until the grinding wheel is in action, passes by to the further side, and returns to its first position, thus finishing one tooth space to proper form. An automatic indexing mechanism (adjustable for any number of teeth within 12 and 60 inclusive) then indexes the wheel one space, and it again rolls along the front of the emery wheel and returns, thus finishing another tooth space.

This operation is repeated automatically until the whole gear has been ground to perfect form. The diameter of the wheel used is 12 inches. The maximum diameter of gear which can be finished is 11¾ inches with a 2-inch face.

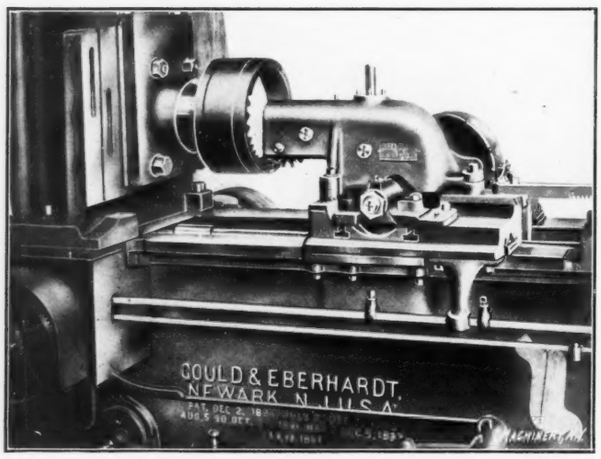


Fig. 60 Attachment to the Gould & Eberhardt Gear-cutter for Cutting Internal Gears.

This machine, which is built by J. E. Reinecker of Chemnitz-Gablenz, Germany, is sold by E. Chouanard, 3 Rue Saint-Denis, Paris, and by C. W. Burton, Griffiths & Co., Ludgate Square, London.

Machines and Attachments for Cutting Internal Gears.

As has been stated, the internal gear is akin to the spur gear, and the machinery for cutting it acts on practically the same principles, except as limitations are imposed by the concavity of the surface in which the teeth are cut, as compared with the convex shape of external gearing. As before, the formed tool method is the most obvious and the most commonly used. The teeth may be cut by a shaper tool with a projecting head, formed somewhat after the fashion of the tools used for cutting keyways in the hubs of pulleys, etc., the work being mounted on the face-plate of an indexing fixture on the table of the shaper, slotter or planer. We have * described a further development of this idea, in which the work was fastened on a face-plate on the spindle of an ordinary automatic gear-cutting machine while the shaping tool was operated by a shaper bodily lifted to a position on the bed of the gear-cutter, and clamped in place there. In such cases the movements are, of course, largely controlled by hand, the tool-holder being fed down into the work.

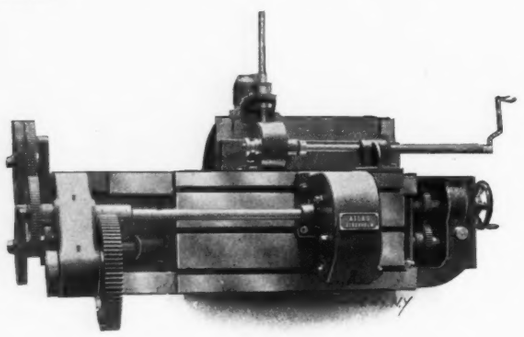


Fig. 61. The Atlas Machine as arranged for Cutting Internal Gears; compare with Fig. 34.

Most machines for internal gears use the formed milling cutter to shape the teeth. A common method of using this process employs an attachment to the regular automatic spur gear cutting machine, carrying the cutter on a projecting arm, adapted to enter the internal gear and work on its inner periphery. An example of this is seen in Fig. 60, which shows the attachment provided by Gould & Eberhardt, of Newark, N. J., for cutting internal gears on their regular spur gear cutting machine. The cutter is driven by a train of spur gears from a driving gear on the regular cutter arbor. The pivots of these gears are shown by the projecting ends of the studs on which they run. While this arrangement furnishes a practical and much-used means for cutting internal gears, it is evident, of course, that it is not possible to take quite so heavy cuts as when cutting spur gears, on account of the indirectness of the means by which the cutter is driven, and the necessarily small diameter of the gear from which it receives its motion.

An attachment of a very similar kind, modified to suit the changed design of the machine, is shown in Fig. 61. This is the Atlas gear-cutter shown in Fig. 34. As may be seen, the attachment is bolted to the face of the cross rail, and is fed down into the work in the same way that the attachment in Fig. 60 is fed forward into it. Other manufacturers make similar devices for use with their machinery.

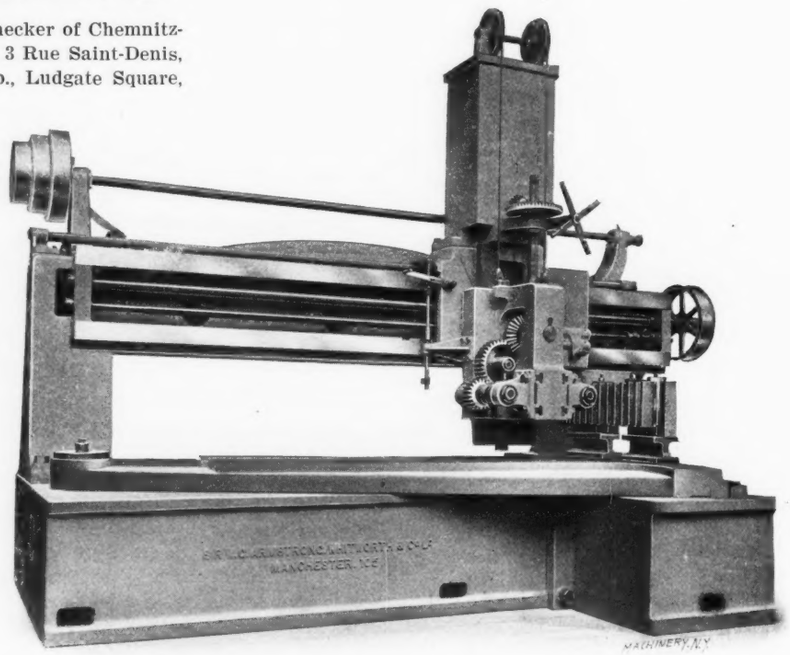


Fig. 62. Armstrong Whitworth Machine for Cutting Internal or External Teeth in Segments of Large Diameter.

In Fig. 62 is shown a machine of great capacity, arranged for the cutting of both internal and external spur gear segments. As posed, it is cutting internal teeth. The work is mounted on a sector pivoted at the left hand end of the bed, and having gear teeth cut in its periphery, by which it is indexed. The work is clamped to this sector at the proper distance from the pivot to give the radius desired. The cutter slide operates on vertical ways on a carriage carried by the cross rail. Two cutter spindles are provided, one on the right and the other on the left hand side of the cutter head, one being used for internal and the other for external gears. The movement is brought to the spindles through a train of spur and bevel gears as shown. This machine, which was designed primarily for dealing with gear segments for gun mountings, will cut teeth in segments having an extreme radius of 13 feet, and a face of 12 inches. It is automatic in all its movements, including the dividing mechanism. Sir W. G. Armstrong, Whitworth & Co., of Manchester, England, are the builders.

The Fellows system of gear cutting, previously described on page 429, is perhaps the most striking method of cutting internal gear teeth. The machine shown in Fig. 63 is forming the teeth in an internal gear. The process, which belongs

* See article entitled "Emergency Methods in Gear Cutting" in the November, 1907, issue of MACHINERY.

to the molding-generating order, is exactly identical to that employed for external spur gears, the cutter and work being geared to rotate together in the proper ratio. It has a number of advantages over the formed cutter method. It does not require the exaggerated clearance at the bottom which the rotary cutter needs for running out into. The cutting tool

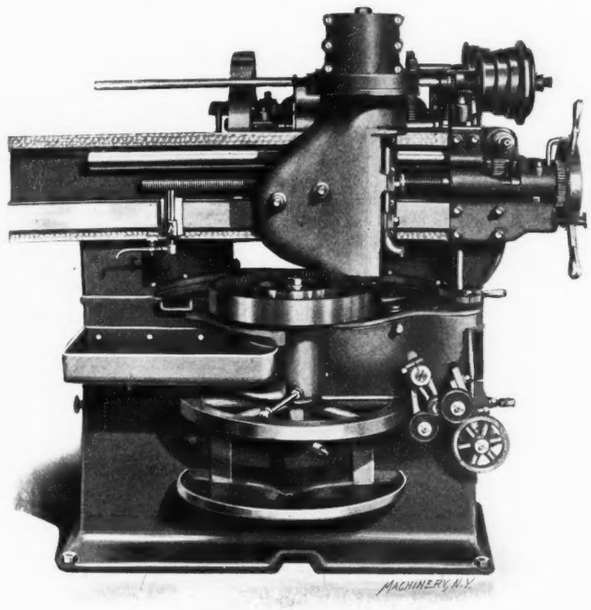


Fig. 63. The Fellows 36-inch Gear Shaper at Work on an Internal Gear.

works to as good advantage as when cutting external gears. No change in the machine is necessary, and special cutters are not required, the same tool being used as in cutting an internal gear of the same pitch. The ease with which internal gears may be cut with this machine, and the fact that it is quite generally used for this work, have encouraged the use of internal gearing in the past few years for cases in which it is better fitted than external spur gearing, but where the difficulty of making it would formerly have barred its use.

The odontographic and describing-generating methods are as limited in their application to internal gearing as to ex-

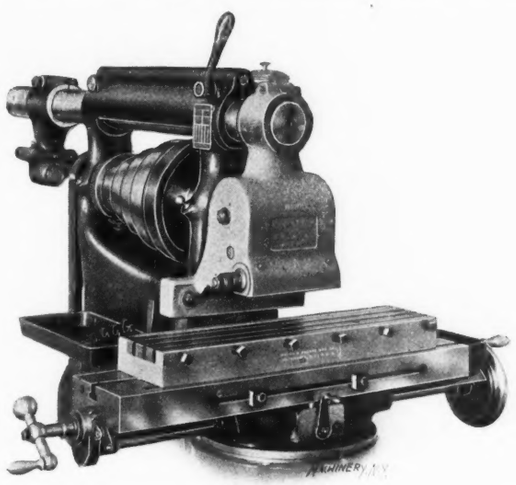


Fig. 64. The Rack-cutting Attachment used with the Brown & Sharpe Milling Machine.

ternal gearing. The grinding or abrasion, and impression operations, also, are seldom, if ever, applied to the cutting of internal gears.

Rack-cutting Attachments to Standard Machines.

As was the case with internal gearing, the formed tool method is that most largely used for cutting racks. The primitive means consists in clamping the work on the table of the planer or shaper, and cutting the tooth spaces with a properly shaped tool in the regular tool-post of the machine. After each space has been cut, the tool-post is moved along the proper distance to bring it in position for a new space—or, in the case of the shaper, the work table is shifted the same amount for the same purpose. A new tooth space is then formed as before, and the operation is repeated until the work is done. In making the measurements for the amount by which to shift the relative position of the work and the tool for each cut, various means may be used. A stop may be provided, set ahead of the previous position by an amount determined by a gage of a thickness equal to the circular pitch of the tooth being cut. After the adjustment has been made for a new tooth, it may again be located in position for the next cut by setting to the proper distance away, as determined by the thickness of the gage. If the screw by which this adjustment is made is provided with a dial reading to thousandths, this may be used. One way is to set the dial carefully to zero before making each setting; then operate the screw to move the slide the proper amount in thousandths of an inch as determined by the circular pitch of the tooth being cut. The dial may then be brought back to zero, repeating the operation when the next adjustment is to be made.

More elaborate means of indexing are provided for special rack-cutting machines. The arrangement generally used is identical with that shown in Fig. 16 as applied to the spur gear cutting machine, excepting that the index worm and

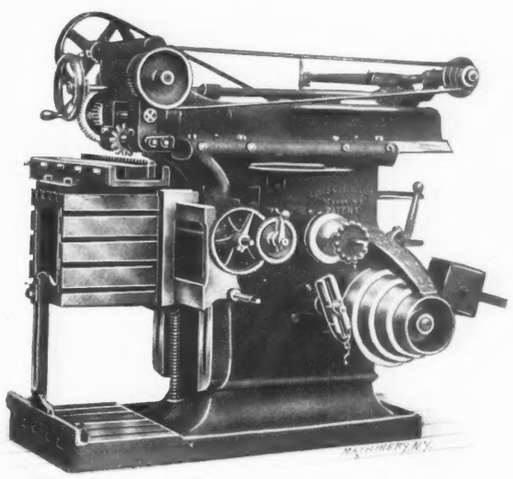


Fig. 65. The Gould & Eberhardt Shaper with Attachment for Cutting Racks.

index wheel are replaced by a lead-screw and nut, which serve to give a longitudinal movement to the work table in the same way that the rotary movement is given to the work spindle of the gear-cutting machine. This longitudinal movement equals the circular pitch, of course, and is obtained by using appropriate change gears between the one-revolution shaft and the lead-screw.

In Fig. 64 is shown an attachment for the milling machine used for cutting racks. This device, which is applied to the Brown & Sharpe milling machines, consists simply of a holder clamped to the front of the column and the overhanging arm, and carrying a short cutter spindle at right angles and below the main spindle of the machine. This is connected to the main spindle by suitable gearing. On the projecting end of it a formed cutter of ordinary construction is fastened. The vise shown in the cut is provided for holding the work. The work may be indexed by using the graduated dial as explained, or by making use of a change gear attachment furnished by the makers, operating on the principle described in the preceding paragraph.

Rack-cutting attachments are also made to apply to the shaper as well as to the milling machine. An example of one made by Gould & Eberhardt, Newark, N. J., is shown in Fig. 65. The regular swiveling tool head has been removed from the ram, and its place is taken by a casting carrying a cutter

arbor, and the necessary gearing and other mechanism for driving it. In addition to this, the ram is provided with attachments for giving a gradual forward screw feed for advancing the cutter through the work, in place of the usual reciprocating movement, which is disconnected when the machine is used in this way. A suitable vise for the work is clamped on the work table, and an indexing arrangement involving the use of change gears is provided for shifting the table from one cut to another.

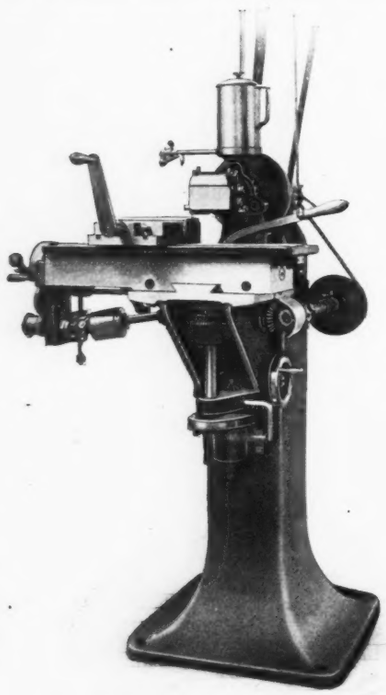


Fig. 66. The Sloan & Chace Rack-cutter for Small Work.

Rack-cutting Machines.

Most commercial rack-cutting machines in their structural design are developments of the milling machine idea. The automatic rack-cutter for small size and accurate work, shown in Fig. 66, is an example of this type. This tool is built by Sloan & Chace Mfg. Co., of Newark, N. J.* Its resemblance to the milling machine and attachment shown in Fig. 64 is obvious. It is automatic in all its movements, which are mostly cam-operated, as is usual in gear-cutting machinery of the precision type built by manufacturers of watch and clock-making machinery.

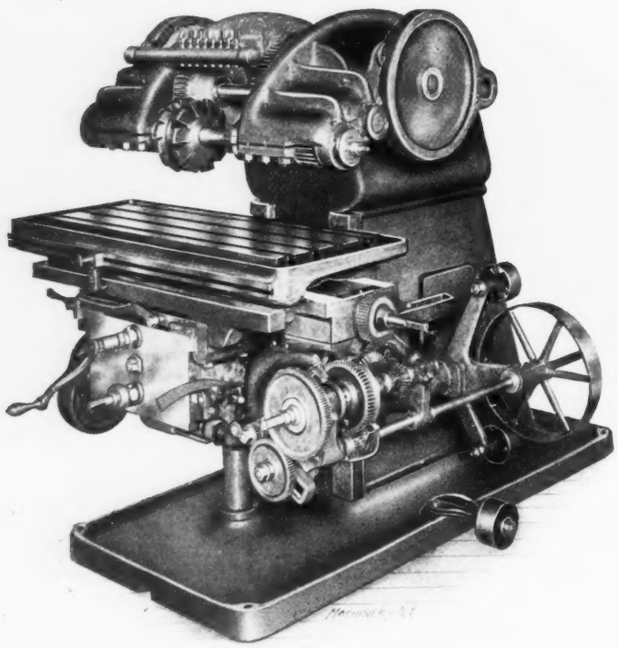


Fig. 67. The Walcott & Wood Automatic Rack-cutter.

Another machine of this kind is built by Walcott & Wood Machine Tool Co., Jackson, Mich.,† (Fig. 67). This machine, as may be seen, involves the same structural features as the preceding one, but is built for much larger and heavier work. Its movements are obtained by screws and gear-driven mechanisms, instead of by cam movements. As shown, the cutter spindle is driven by gearing on each side, the main drive on the left being by herring-bone gears. This tends to give a smoothness of action which the necessarily small diameter of the driving pinion would otherwise make impossible. The cutter arbor is driven by a tongued connection from each end. It is held in position by two bolts passing through the driving spindles at each side, which, when tightened together, make driving spindles and cutter arbor practically a solid piece, giving a very powerful support. There being 10 inches of cutter space on the arbor, it is well adapted to the use of gang or multiple cutters. Provision is made for this in the gearing, there being two sets of change gears, one of them set for the pitch in the ordinary way, while the other is set for the number of teeth it is desired to index at once. All of the gears shown are provided with guards, which have been removed in taking the photograph so that the drive may be more easily understood. A feature of this machine and the previous one is the automatic mechanism provided for throwing off the counter-shaft belt shifter when the required number of teeth has been cut.

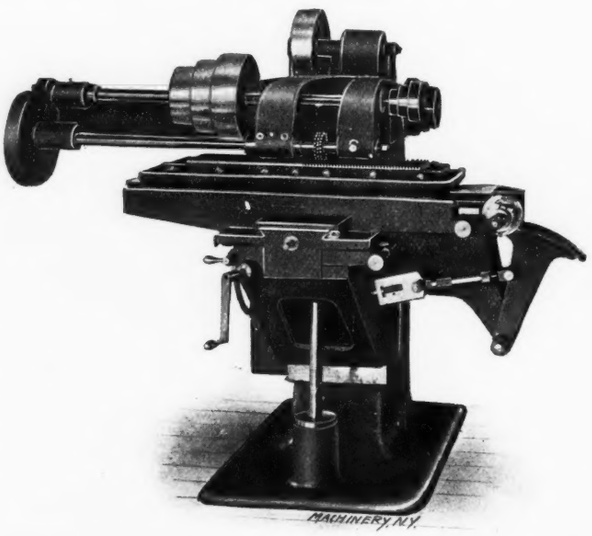


Fig. 68. The Machine built by Warner & Swasey Co., to overcome the Driving Difficulty.

In the machine shown in Fig. 68, formerly built by Warner & Swasey Co., of Cleveland, Ohio, the difficulty in the driving of the cutter spindle has been ingeniously overcome. The cutter spindle has been extended to great length at the left side of the machine, where it is driven by a gear of as large diameter as is necessary to give it a powerful, yet smooth and even movement. Of course the capacity of the machine for cutting racks is limited to the length from the cutter to the face of the driving gear. This is beyond the extreme indexing range of the table any way, but the possible range may be doubled by cutting half the rack, and then reversing it so that the overhang of the work is at the right end of the table. The efficacy of this method of driving the spindle in avoiding some of the difficulties inherent in the rack-cutter, may be vouched for from the fact that the idea in a modified form has been applied to all the rack-cutters of various types in the plant of one of the largest firms making a special business of cutting gear teeth.

Another point of interest is the indexing movement, which differs somewhat from that previously described. A slotted crank on the front of the bed is given one complete revolution for indexing. This crank operates the sector shown at the left of the table. This sector has teeth on its periphery, meshing with a ratchet gear by which the indexing lead-screw is driven. The setting of the crank-pin in the slotted crank at various positions determines the arc through which the toothed sector swings, and determines, in consequence, the amount of movement given by the ratchet to the lead-screw, thus determining the circular pitch of the rack.

* See "Machinery and Tools" in the January, 1907, issue of MACHINERY.

† See "Machinery and Tools" in the September, 1906, issue of MACHINERY.

JIGS AND FIXTURES IN THE PRATT & WHITNEY CO.'S SHOPS.

There are three distinct reasons for the use of jigs and fixtures in the manufacture of machinery. In the first place, jigs and fixtures are employed for reducing the cost of the article manufactured; in the second place, a higher degree of accuracy is attained; and in the third, the interchangeability of the parts manufactured is effected. One of the first firms in this country to realize the importance of these points and to use tools for interchangeable manufacture on a large scale was the Pratt & Whitney Co., which, in the late seventies and early eighties, was one of the pioneers of modern machine tool construction in this country, and which then commenced to introduce the application of jigs and fixtures in a degree previously unheard of. Since these early days of machine tool construction, the company has adhered to its policy of using special tools in the greatest possible degree, and many of the appliances designed and used are both elaborate and costly, but, as they serve the three objects mentioned above, the tendency is constantly toward more tools and more efficient devices.

Hardly any operation of consequence in the shops of this company is performed without the use of some special tool or fixture, whenever time or accuracy can be gained by the use of such appliances, and many of the tools used are so ingenious and complete in their design as to classify them rather as special machines than as jigs or fixtures. In the following, a few of the tools used in the Pratt & Whitney Co.'s shops, are described and shown. Some of the tools will be found to have a direct bearing on nearly any kind of machine construction, while others will have at least a great deal of suggestive value, and indicate the lines along which similar tools for kindred operations may be designed.

As is well known to almost every mechanic, one of the standard products of the Pratt & Whitney Co. is turret lathes, of which several sizes are built. In the half-tone, Fig. 1, the bed of one of these turret lathes is shown in position on a horizontal boring machine, to bore the spindle bearings. As will be noticed, the head and bed are cast integral. The fixture, which is shown clamped to the table of the boring machine and which holds the bed while the bearings are being bored, clamps the work by means of pneumatic pressure. The general design of this fixture is shown in the line illustration, Fig. 2, the only difference between the fixtures in Figs. 1 and 2 being that in Fig. 2 a fixture is shown which is used for turret lathes having back gearing, while the fixture shown in Fig. 1 is for one of the smaller sizes, not provided with back-gears. Referring to Fig. 2, the work is held down by four clamps *A* continuing down through the body of the fixture to an equalizing lever *B*, which is connected to a piston *C*

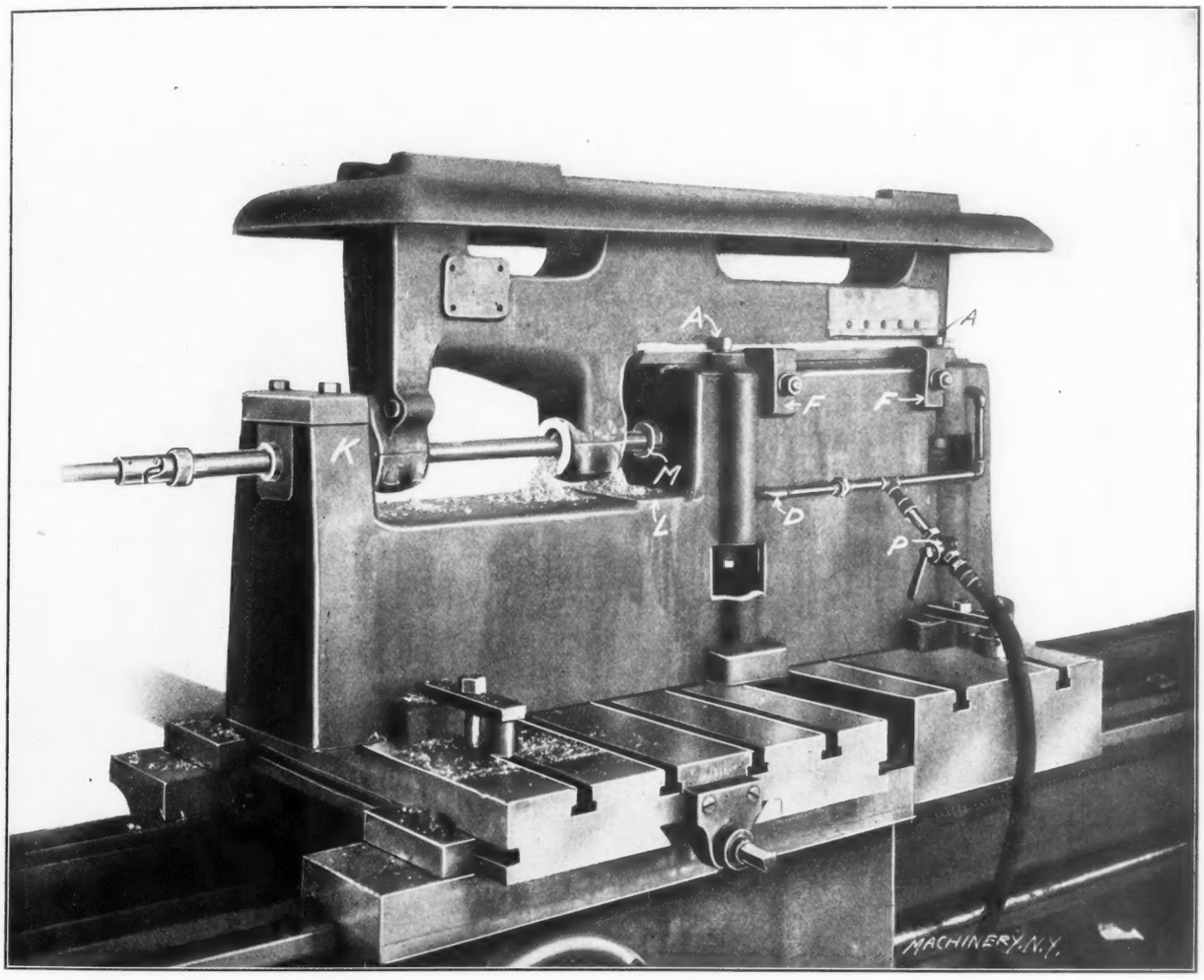


Fig. 1. Boring Fixture for Turret Lathes, with Pneumatic Clamping Arrangement.

actuated by air pressure. The required movement of this piston and of the clamps *A* is very small, because the ways of the bed are finished before being placed on this fixture, and consequently there is no need of allowance for variation. The air for the cylinder in which piston *C* moves is supplied through the pipe *D*. There are two sets of clamps, one at the front and one at the back end of the bed, both being supplied from the same main pipe as is plainly shown in the half-tone, Fig. 1, the clamping being effected by simply turning the handle on the air valve *P*.

In order to place the bed casting in position before clamping, the beveled surface *E*, Fig. 2, on the fixture, is planed to the same angle as the ways of the bed, and the bed is forced up against this bearing surface by means of two clamps *F*, previous to applying the air pressure. Springs *G*, of which one is shown in the end view of Fig. 2, serve the purpose of lifting the clamps from the work, as soon as the

air pressure on the piston is relieved, and the clamps can then be swung aside so as not to interfere with lifting the casting out of place, or the placing of a new casting in position.

The general construction of this fixture is also rather interesting. At *H* is shown a supplementary projection or lug, which is removed as soon as the holes in the back end *M* of the fixture have been bored to receive their bushings. This

It will be noticed that there are a number of circular grooves cut on the surface of the plunger *C*, Fig. 2. It has been found advantageous to have these grooves on the plungers, and to fill them with vaseline, as this will act as a lubricant and permit the plunger to move freely, and at the same time act as a packing, preventing the escape of air.

Another tool of great interest and ingenuity of design is used for facing the ends of the bearings in the head of the

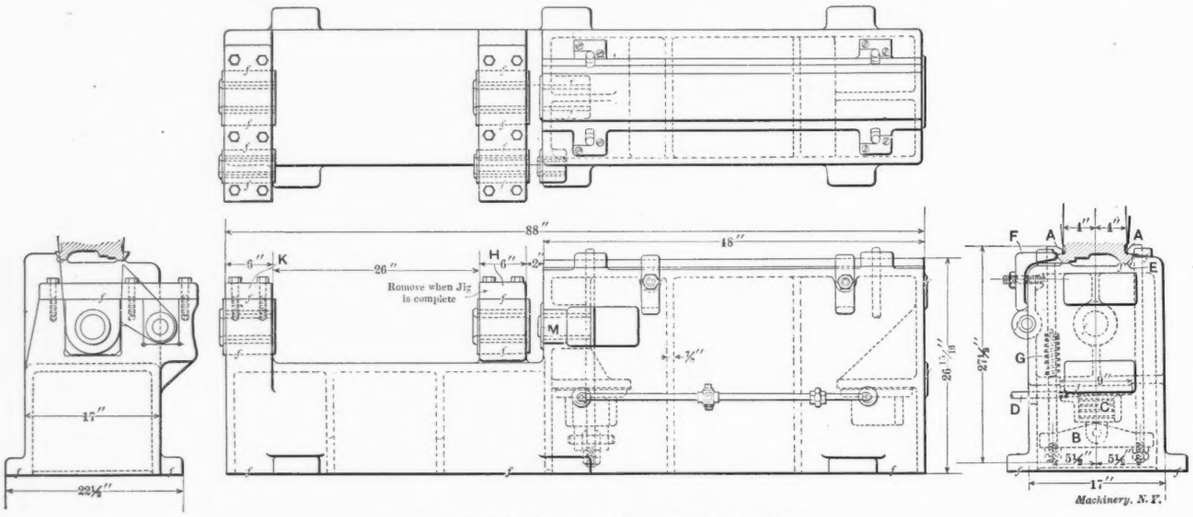


Fig. 2. Plan and Elevation of Fixture shown in Fig. 1.

lug, containing bushings the same as those in the front projection *K*, serves simply the purpose of giving support to the boring bars, while boring the fixture, so that the holes in the fixture itself may be placed exactly in line. In Fig. 1 the pad *L* shows where this auxiliary lug has been removed.

One difficulty has been experienced with this clamping device. When a head was half bored at the time when the power was shut down at night, it was found that the clamps, on which, of course, the air pressure was relieved during the night, would not hold the bed in exactly the same position when the air pressure would be again applied, but that some slight variations were noticeable, and it became necessary tc start the boring of the holes anew, in order to get them to line up exactly. For this reason, some of the fixtures of this design have been provided with small auxiliary clamps, which can be applied before the air pressure is relieved, whenever it is desired to hold the bed over night in exactly the same position as before. These clamps, being applied, will then prevent any motion of the casting, when the clamps *A* release their grip. The auxiliary clamps, of course, need not

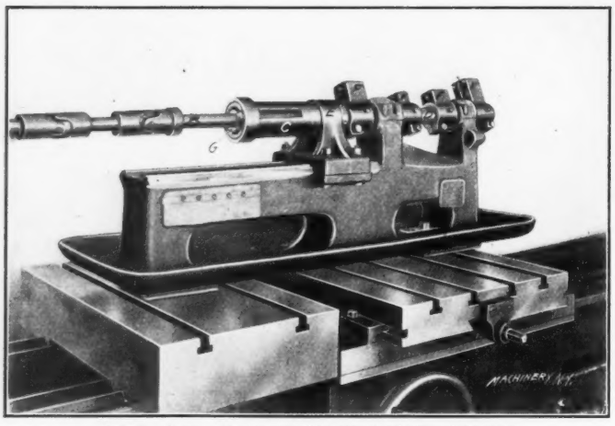


Fig. 3. Device for Facing the Head of Turret Lathes.

be applied excepting in such cases when the air pressure is to be shut off. In order to insure that the bed bears properly against the locating surface *E*, and also on the top portion of the fixture, feelers of tissue paper are put in between the bed and the fixture at six places—two on each side and two at the back end—and by means of these the proper location is ascertained.

turret lathes. This tool is shown in operation in Fig. 3, and details showing some of the component parts are shown in Figs. 5, 6, 7, and 8. The principle of this fixture is that the facing tool, inserted at *A* in the tool-holder shown in Fig. 6, moves automatically from the outside of the boss to be faced toward the center, the four faces of the head being faced off simultaneously. The fixture consists, in general, of a feed bar *B;* a feed bar sleeve *D;* a driver *C;* a driving clutch *G;* a

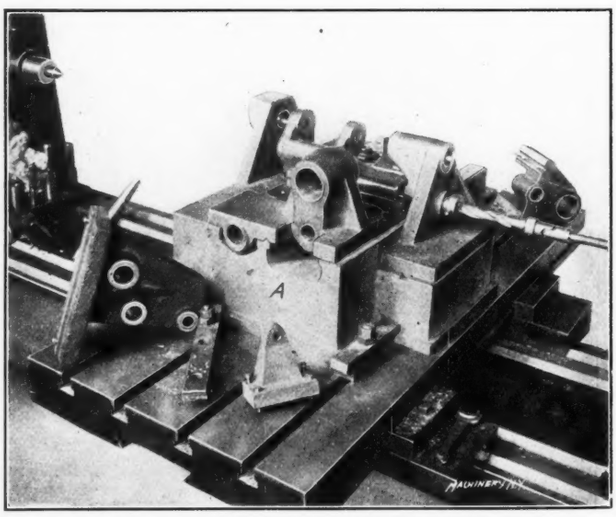


Fig. 4. Fixture for Boring Head-stock, Foot-stock, and Carriage for Thread Milling Machines.

supporting thrust bracket *E;* and four tool-carrying heads *F*, with tool-holders and tools. The bracket *E* is first clamped to the bed of the machine, the bearings of which are to be faced, the machine itself being placed on the table of the boring machine. This bracket *E* acts as a support and guide for the boring-bar sleeve *D*, on which the heads *F* are mounted, and which is keyed to driver *C*, thereby giving the rotary motion to the heads. Sleeve *D*, however, is held stationary endwise. There is little or no actual end thrust, as far as the cutting operation is concerned, inasmuch as all the four faces are finished at once, and the two opposing ones actually equalize one another in regard to end thrust. What end thrust there is, is caused by the feeding in of the tools toward the center, as explained in the following.

The feed-bar *B* is designed in a manner as shown in Fig. 5. On the end, connecting with the ball joint, it is circular, but the portion of the bar which enters in the sleeve *D* is milled down, as indicated, and at the places where the four heads *F* are located, it is provided with ridges and grooves, as shown at *H*, Fig. 5. These ridges and grooves engage with similar ridges and grooves in the tool-holder, Fig. 6, and it is evident that when the table of the boring machine, to which the bed of the machine being faced is clamped, moves toward the head of the boring machine, so that the boring bar *B* is pushed forward, the engagement of the grooves in this bar, with the ridges in the tool-holder, forces the tool-holder to move in a direction at right angles to the axial direction of the boring-bar, so that the tool inserted at *A* in the tool-holder is fed from the outside periphery toward the center of the bosses on the head. The heads *F*, as mentioned before, are mounted on the sleeve *D* and are held stationary in relation to the bed through bracket *E*, so that there is no endwise motion of the tools in relation to the bed of the machine.

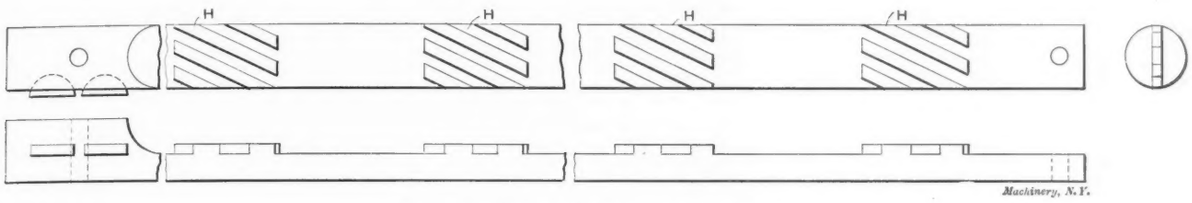
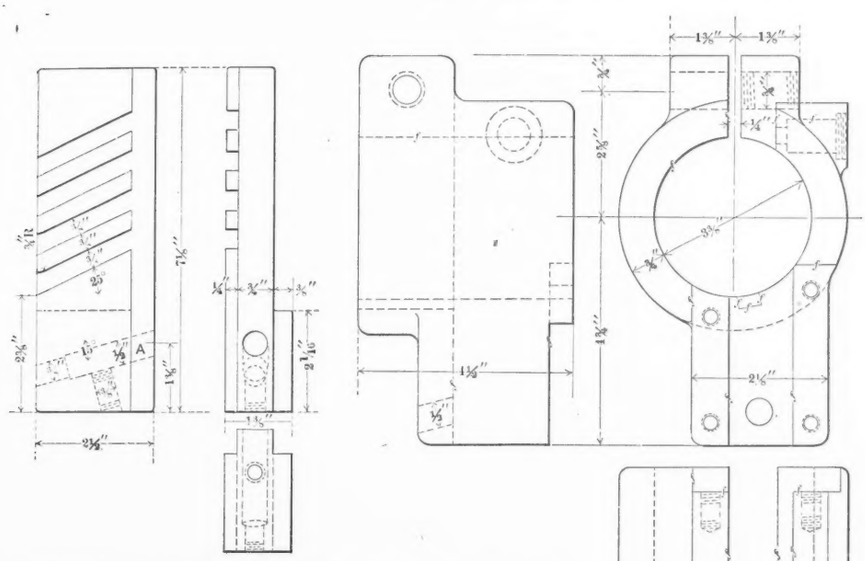


Fig. 5. Feed Bar used in Device shown in Fig. 3.



Figs. 6 and 7. Tool-holder for Facing Device, and Tool-carrying Head.

In Fig. 7 is shown a detailed drawing of one of the tool-carrying heads *F*, which acts as a guide and holder for the tool-holder in Fig. 6, and in Fig. 8 is shown a section through the head, when the tool-holder and feed bar are inserted. In this section, *B* represents the feed bar; *D*, the sleeve; *F*, the head itself; *K*, the tool-holder; and *L*, the facing tool. At *M* is shown a pin having a knurled head. This pin presses against the side of the tool-holder, and is actuated by the spring *N*. As soon as the tool-holder has been fed inward by the forward motion of the feed bar, so that the ridges and grooves of the feed bar have passed entirely through the corresponding grooves in the tool-holder, and the bar has disengaged the holder, the end of this pin enters into the corresponding hole *P* in the tool-holder. This prevents the tool-holder, which still has a rotating motion imparted by the head, from being entirely loose in the head, and from falling to and fro, according to which side of the head is turned upward.

The half-tone, Fig. 4, shows a fixture which is used for boring the head-stock, foot-stock, and the carriage which holds the cutter head for the thread milling machines, built by the Pratt & Whitney Co. Originally, special fixtures were made for boring each one of these three parts of the machine, but it was found that it was difficult to get all the holes to line up exactly when the different parts were placed on the bed of the machine. It is evident that it is necessary that the center of the holes, in which the cutter head swivels when it is set for milling, should be exactly at the same height as the center of the spindle of the machine, in order that the cutters may cut the exact shape of the thread desired, in the same way as it is necessary to have the thread tool set exactly at the height of the centers of the lathe, in order to obtain a perfectly shaped thread. In order to overcome the difficulty referred to, the fixture shown was designed. This fixture, in fact, consists of a short portion *A* of the bed of the machine itself, and the various parts are placed directly on this bed when being bored. The brackets shown lying on the table of the boring machine are used for the different parts of the machine, and are put in place as required. They are being located by dowel pins, so as to insure that they will always come in the same exact relation to the main bed *A*. It is evident that this provision permits all the parts that go on the bed of the thread milling machines to be bored so as to be perfectly interchangeable with one another, and at the same time that all the holes required to line up in the assembled machine will have a correct location.

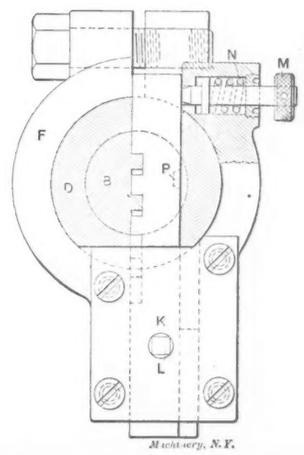


Fig 8. Section through Tool-carrying Head, with Feed Bar and Sleeve in Position.

The fixture shown in the half-tone, Fig. 9, is used for drilling the holes *K* and *L* in the casting in the line cut, Fig. 10, and also for drilling the corresponding holes in the bed of the machine onto which the casting is attached. This casting is what is known as the motion bracket on an automatic screw machine, built by the company, a worm being placed between the faces *A A*, working with a worm-wheel located on a stud in the frame of the machine. The fixture is also used as a gage for testing the worm-wheel after hobbing. As will be seen from the line cut, the casting is of a rather complicated design, and it would be rather difficult to drill holes in this casting, and then drill the corresponding holes in the bed of the machine, so that they would line up perfectly, unless as here, the same jig were used for both operations. When the piece in Fig. 10 is placed in the jig, shown in Fig. 9, the bottom face *B* is already planed, and it is clamped with its face against the finished pad on the jig, the holes then being drilled in the bracket. For sideways location, the

bracket is located by a movable stop, shown at *M*, so located that the center between faces *A* comes exactly in line with the center of the worm-wheel, which, when this fixture is used for a gage, is held on a stud entering the hole, shown at *C* in Fig. 9. The side of stop *M* locates the work by pushing face *A* of the casting up against it. When the bed is

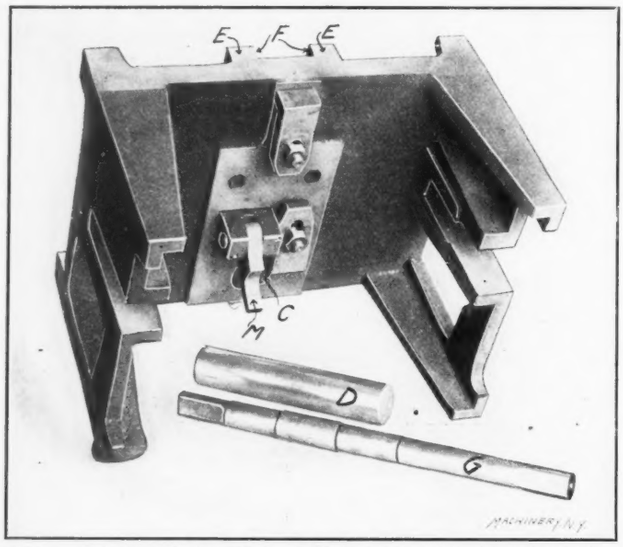


Fig. 9. Jig for Drilling Screw-holes in Casting shown in Fig. 10, and for Drilling Corresponding Holes in Frame; also employed as a Worm-wheel Gage.

drilled, the jig is located through the stud *D*, Fig. 9, entering through the hole *C* in the drill jig, and at the same time through the hole already bored for the shaft of the worm-wheel in the bed. This locates the jig in relation to the height. To locate it sideways, the two lugs *E*, shown on the back of the fixture, are employed, the faces *F* fitting a finished projection on the machine. In order to permit the holes *K* to be tapped while in the jig, the bushings are removable. When the fixture is used as a gage for the hobbed worm-wheel, the bracket is clamped to the fixture in the same manner as when it is being drilled. The shaft *G* is

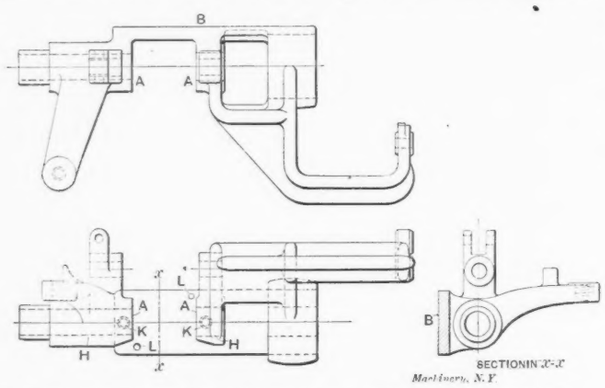


Fig. 10. Motion Bracket for Automatic Screw Machines—drilled in Jig Fig. 9.

placed in the bracket through the hole *H*, and a master worm is placed on this shaft. The stud *D* is then placed in the hole *C*, and the worm-wheel is placed on this stud. It is evident that, if the master worm fits the worm-wheel exactly when tested under these conditions, both the bed and the bracket having been drilled in this jig, it must necessarily follow that the worm and the worm-wheel will fit each other, when placed in position in the machine.

A most interesting device is shown in the half-tone, Fig. 11, and the line cut, Fig. 12. This device is intended for milling dove-tail slides in a vertical milling machine. As will be seen from the half-tone, Fig. 11, the device consists of a bottom plate *A*, in the center of which is pivoted a table *B*, provided with three T-slots. On this table is mounted the work holder plate *C*, provided with screws and studs for holding the work. At *D* is shown a dove-tail slide, placed on the device and milled to the desired dimensions. At the corners of the base plate *A* are shown disks *E* and *H*. These disks serve as gages when the device is used. The operation is as follows: When the work has been placed in position on the work holder, the table is fed forward, and one side of the slide is milled, the cutters used for milling being of the form shown in Fig. 14. As soon as one side is completed, the operator releases the handle *F*, which is attached to a stud, which binds the table *B* to the bottom plate *A*, and, with the other hand on the handle *G*, he swings the table around until it rests up against the side of the disk *H* at the other end of the base plate. In this position it is located to mill the other side of the dove-tail slide without changing the setting of the machine. When the disks *E* and *H* are of equal size a straight dove-tail slide will result, but if it is required to have the slides so milled that a tapered gib may be used, then one of the disks may be made larger than the other, the dimensions, of course, being determined by the taper required. One side of the dove-tail slide will then be milled straight, while the other will be made on the required taper. A tool steel piece *K* is inserted in the table *B*, where it strikes up against the hardened disks *E* and *H*, so that the device will stand without perceptible wear the constant impact that results from being pressed up against the disks.

In order that the disks may be figured and made once for all, and standard gages used for setting the cutters, it is necessary that one end of the slide to be milled be always

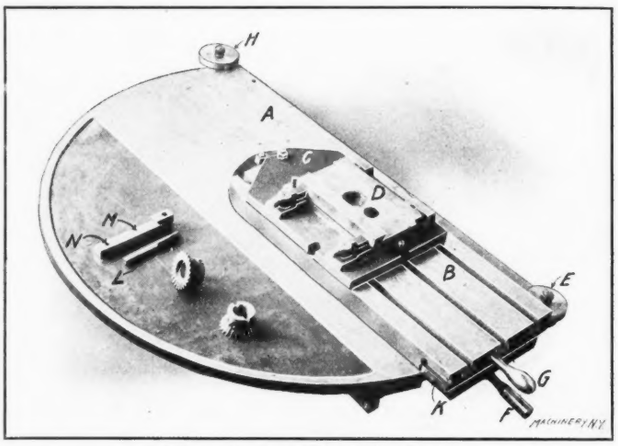


Fig. 11. Dove-tail Slide Milling Device.

a certain distance from the center of rotation. To ascertain this, a hole is drilled in the work holder *C*, and the work is located so that the center of this hole is exactly in line with the end of the work being milled. This hole is not shown in the cut, but the work is always so set that the end of the slide to be milled comes exactly at the center of this hole. The work-holding slide must, of course, itself be so clamped

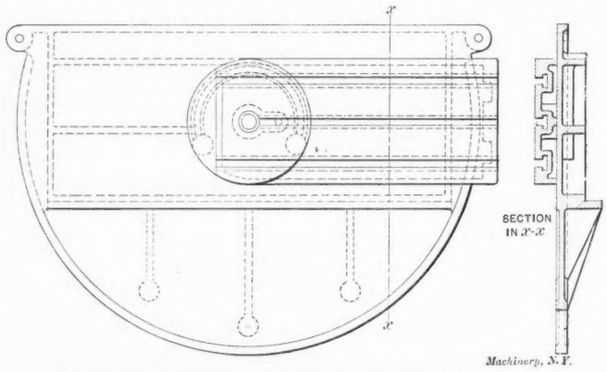


Fig. 12. General Construction of Dove-tail Slide Milling Device.

in relation to the table *B* that the distance between the center of the hole referred to and the center of rotation is constant. The gage pin *L* is used for this purpose. A hole is drilled in table *B*, exactly three inches from the center of rotation, and the gage *L* is put through the holes in the work holder *C* and the table *B*, so that the exact relation is obtained. At *M* is shown one of the gages used for setting milling cutters to obtain exact sizes of the dove-tails. The hole at *N* is also

intended for the gage *L* which enters into this hole and into the hole in *C*, before mentioned, and thus locates the gage exactly in relation to the device.

The line cut, Fig. 12, simply shows the general details of the construction of the device. The cutters used, shown in Fig. 14, have one interesting feature. The cutter is first turned up to the shape shown at *O*, and then every alternating tooth is made as shown by the full line at *P*, and every remaining tooth as shown by the dotted line. This construction is used in order to get a sharp corner at *R*, it being desired to mill, at the same time that the dove-tail is milled, the small flat, which terminates the dove-tail, and prevents a sharp corner at the upper edge between the top and the beveled surface. Of course, in order to make a cutter this way, each tooth will have to be operated upon separately and given the desired shape. It is evident that this is rather a costly operation, but it insures efficient results.

In Fig. 13 is shown a universal fixture used for the boring of the largest size of turret lathes (3 x 36 inches), and also for the die-sinking machines made by the company. This

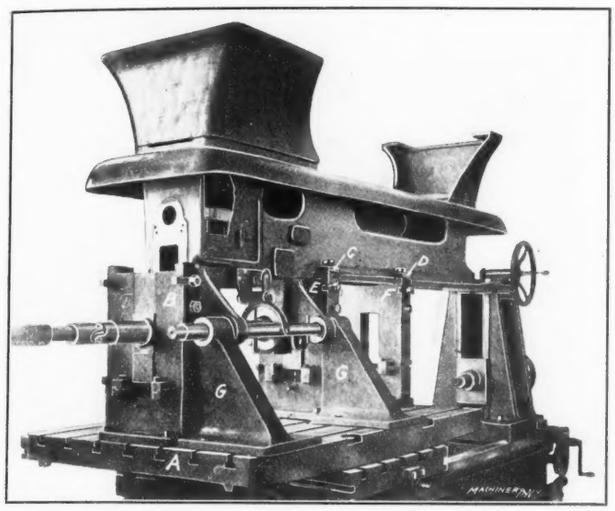


Fig. 13. Fixture for Boring Large Size Turret Lathes.

fixture consists of an auxiliary table *A* which is placed on the regular table of the boring machine. On this table are placed the brackets and uprights which guide the boring bars. The uprights *B*, *E* and *F* are provided with slots for a certain distance down, and in these slots are placed square guide blocks which hold the bushings for the boring bars. The construction permits of adjusting the bushings to different positions for different machines, and the arrangement makes a very useful and universal tool for interchangeable work. The

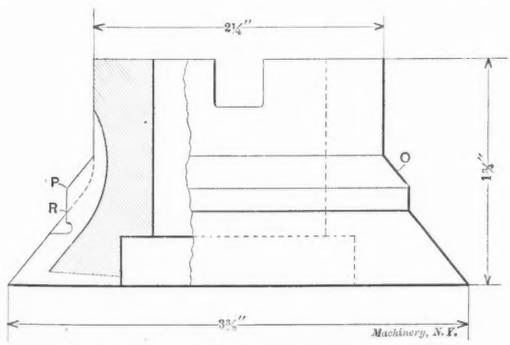


Fig. 14. Cutters used for Milling Dove-tail Slides.

machine is clamped to the fixture by clamps at *C* and *D*, and rests entirely on the uprights *E* and *F*. The bed and the pedestals complete, arranged on the table of the boring machine, as shown, weigh approximately 2,800 pounds.

It will be noticed that, for boring the holes for the back-gear shaft, two separate brackets *G* are used, shown at the front of the table *A*. For some work, which is not made in sufficient quantities to warrant the expense of making separate brackets, two heavy knees, with adjustable arms, as indicated in the perspective drawing in Fig. 15, are used. As will be seen, there are vertical slots in the knee, and slots at right angles to these in the arm clamped to the knee, so that the guide bushing for the boring bar can be placed at any position required. These arms are provided with removable bushings, so as to accommodate the different sizes of boring bars and fill the requirements fully as well as the removable brackets, excepting, of course, that they have to be set to the correct position every time they are changed from one job to another. The arrangement shown in Fig. 13

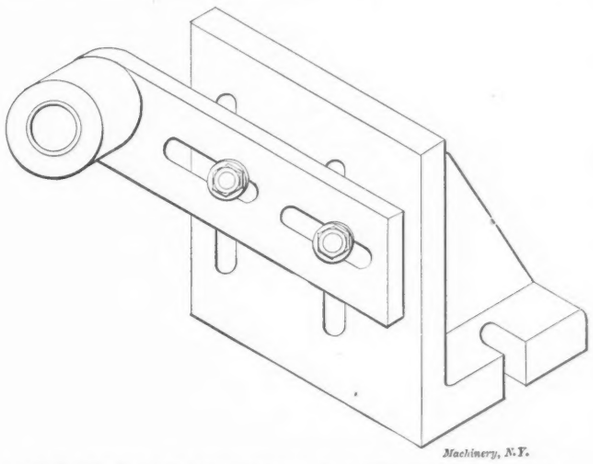


Fig. 15. Bracket with Adjustable Arm for holding Boring Bar Bushings used with Fixture shown in Fig. 13.

illustrates also how in the modern machine shops the size or the weight of the machines being operated upon does not interfere in any way with their being placed in the most convenient way for the operation of the tools, and that comparatively simple devices, if provided with adjustable features, may be used for operations requiring great accuracy.

The illustrations of the tools shown above (the devices having been reproduced directly as used in the shops) may suggest a great deal more than has been conveyed by the description itself. Photographs are one of the best means of conveying ideas in mechanical work, as they often show to each individual exactly the things that he may be most interested in, whereas a description may often ignore certain points, seemingly of more trivial interest, which to some may be considered as the most interesting points. The half-tones shown also illustrate plainly that in our most modern machine tool shops there is no limit to the application of special tools to the operations performed in building machinery, and that by the use of such devices work can be carried out in a fraction of the time that was formerly required to carry out the same operations. E. O.

* * *

Some years ago (October, 1899) an article was published in MACHINERY on the manufacture of hydraulic jacks as carried on by a well-known concern, and in it the importance of the unit system was pointed out as applied to this business. The number of devices and designs of hydraulic apparatus is very large, there being literally hundreds of jacks, presses, etc., listed which the concern is prepared to supply on short notice, but this does not mean that there are as many designs of the pumping mechanisms as there are designs of jacks listed. On the contrary, these costly parts are standardized and are manufactured entirely apart from the general construction of the apparatus in which they may be used. The general line of apparatus is designed to use these standard parts, and they are assembled in exactly the same essential form as they appear, for example, in the ordinary hydraulic jack.

* * *

The common process of protecting metals by plating them with copper or other metals by electrolysis is often inconvenient because of the large size of vat necessary. It has been found possible to apply the electrolyte with a paint-brush attached to one pole of the source of current. By this means a smooth, strong coating of metal may be built up to any reasonable thickness. This process, it is said, has been successful in plating with silver, gold, copper and nickel.

TAPER TAPS.—1.

ERIK OBERG *

Taper taps, if the expression be properly understood, are taps which have the diameter of the thread nearest the shank larger than the diameter of the full thread at the point, the intermediate portion being formed by the gradual taper from one end of the thread to the other. It is necessary to call attention to this proper meaning of the expression taper tap, because of the fact that the first tap in a set of hand taps is commonly, but not properly, referred to as a taper tap. As this expression is used to designate two widely different things, and as its common usage in connection with the first tap in a set of hand taps prevents any possible change, it is always well, when speaking of taper taps, to state which of the two meanings is referred to in any particular case. In the present discussion, we are referring to the taps properly termed taper taps; that is those with the diameter of the full thread at the point smaller than the diameter of the thread at the end nearest the shank.

There are three particular points to take into consideration when making taper taps. In the first place, the threading tool must be presented to the tap at right angles to the axis

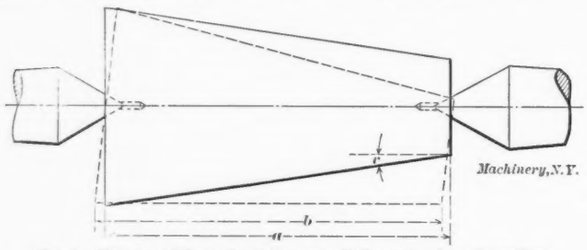


Fig. 1. Showing Effect of setting over Tail-stock when threading Taper Taps.

of the tap, and not at right angles to its tapered surface, unless the tool is specially made for taper threading of taps with a definite taper. In the second place, taper taps should, if possible, be turned on lathes being provided with taper attachments, and not by setting over the tail-stock of the lathe, and, finally, proper relief should in all cases be given a taper tap. The first of these questions was treated at length in the article entitled "Cutting Taper Threaded Taps with Chasers," which appeared in the May, 1907, issue of MACHINERY. The second and third questions will be dealt with in the following.

Effect of Setting Over Tail-stock when Threading Taper Taps.

If the old method of setting over the tail-stock is used when cutting taper threads, two errors will be introduced, and these errors will increase as the taper of the taps increases. The first error consists in the pitch of the thread becoming finer than the standard, which is readily seen by referring to Fig. 1. The length of the work shown between the centers of the lathe is a, if measured along the axis of the work. If measured along the tapered surface the length is b; but $b = \frac{a}{\cos v}$, if v be the angle which the side of the tapered piece makes with the center line. If the piece is threaded with a certain number of threads per inch c, the number of threads when threading by means of a taper attachment would be $a \times c$, but if the threading is done with the tail-stock set over, as shown by the dotted lines, the number of threads would be $\frac{a}{\cos v} \times c$, or a greater number of threads, and consequently a finer pitch, than in the first case.

An example will plainly demonstrate the case. Let the length a, measured parallel to the axis, be 12 inches. Assume that we wish to cut 10 threads per inch and that the angle v is 8 degrees. The number of threads on the whole length of the piece, when cut in a correct way by means of a taper attachment will be 120 threads. Now, the length b, or the length of the piece measured parallel to the outside, equals $\frac{12}{\cos 8 \text{ deg.}} = 12.121$, or 12⅛ inches approximately. In this length we would get 121¼ threads instead of 120. It is thus evident that for steep tapers the difference is quite considerable, and cannot be overlooked.

* Associate Editor of MACHINERY.

"Drunken" Thread.

The second error, due to setting over the tail-stock when cutting a taper thread, consists in that the thread, instead of becoming a true, continuous helix, becomes "drunken." An exaggerated drunken thread is shown in Fig. 2. The drunken thread is due to the fact that in taper turning with the tail-stock set over, the work does not turn with a uniform angular velocity, while the cutting tool is advancing along the work longitudinally with a uniform linear velocity. The change in the pitch and the irregularity of the thread is so small as to be imperceptible to the eye if the taper is slight, but as the tapers increase to say ¾ inch per foot or more, the errors become more pronounced. While the setting over of the tail-stock for cutting taper threads should be as much as possible discouraged, in such cases where it is necessary, however, the detrimental effects of the method may be partly overcome, at least in as far as the cutting qualities of the taps are concerned, by relieving the threads liberally. This will, obviously, not correct the errors in regard to incorrect pitch or imperfect helix of the thread, but it will cause the tap to cut freely, even if it does not produce a theoretically perfect thread of the desired pitch and form.

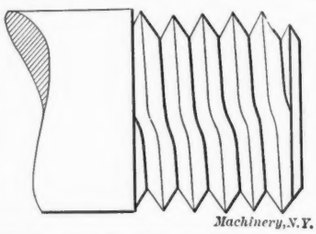


Fig. 2. "Drunken" Thread, Exaggerated.

Amount of Error due to Setting Over the Tail-stock.

In Table I, figures are given stating the amount a tap will be *short in the lead per foot* for various tapers, if threaded with the tail-stock set over. The amount of taper is always, in regard to taps and reamers, intended to mean the *difference in diameters per foot of length* measured along the center line or axis of the tool. By means of the table given, it is easily seen whether the inaccuracy produced will be of consequence

TABLE I. AMOUNT OF SHORTAGE IN LEAD IN ONE FOOT OF SCREWS THREADED BY SETTING OVER THE TAIL-STOCK.

Taper per foot.	Error in Lead per foot.	Taper per foot.	Error in Lead per foot.
$\frac{1}{16}$	0.0001	$1\frac{1}{2}$	0.023
$\frac{1}{4}$	0.0006	$1\frac{3}{4}$	0.031
$\frac{3}{16}$	0.0014	2	0.042
$\frac{1}{2}$	0.0026	$2\frac{1}{2}$	0.065
$\frac{3}{4}$	0 0041	3	0.094
$\frac{3}{4}$	0 0058	$3\frac{1}{2}$	0 126
1	0.0108	4	0.164
$1\frac{1}{4}$	0.0168	..	.....

in a particular case or not. It is also seen that the error for reasonable tapers is very small indeed, so small, in fact, as to have no commercial importance whatever.

The amount of the error in one inch is figured from the formula

$$\text{Shortage in lead in one inch} = 1 - \cos v,$$

if v is figured from the formula

$$\tan v = \frac{t}{2 \times 12},$$

in which latter formula t is the taper per foot of the piece to be threaded.

An example will tend to make the formula more easily understood. Suppose the taper per foot of a particular piece of work is ⅝ inch. The angle v is then first determined:

$$\tan v = \frac{0.625}{2 \times 12} = 0.026$$

$$v = 1 \text{ degree } 30 \text{ min.}$$

The amount the lead of the thread will be short is one inch, if threaded with the tail-stock set over, equals

$$1 - \cos 1 \text{ deg. } 30 \text{ min.} = 0.00034,$$

or about 0.004 inch per foot. Being a fairly small taper we see that the amount of the error is comparatively slight. If

the taper is increased, however, the error will soon assume such proportions as to be negligible only in very rough work.

Relief of Taper Taps.

The third, and perhaps the main, consideration in regard to making taper taps is the question of a proper relief. This question has been a greatly perplexing one in machine shop practice, particularly in the case of taps with steep tapers. It is evident that a taper tap, not relieved either on the top or in the angle of the thread, will refuse to cut altogether, or, if forced through a hole, will either leave a very rough and irregular thread, or break off its own teeth. This depends upon that, as the tap is continuously tapering upward, the heels of the teeth are always located in a circular section of a larger diameter than the cutting edge of the corresponding tooth. Consequently, if forced to cut a thread, the tap, if not relieved, will squeeze the metal back of the cutting edge in order to find room for the increasing diameter. While the edge cuts, the space produced by the cutting point of the thread is not large enough for the increasing diameter of the part of the thread immediately following. On account of this, it is imperative that taper taps be relieved the full length of the thread, on the top as well as in the angle of the thread, for the full width of the land. Referring to Fig. 3, the relief should also be greater on the side *D* than on the side *E* of the thread. This will lessen the friction and the resistance while cutting a thread, inasmuch as it is obvious that the greater pressure on the thread of the tap created by the cutting process comes on the side *D*. Thus, if this side is properly relieved so as to permit only the cutting edge to come in contact with the material to be cut, the friction is reduced to the smallest possible amount, and at the same time the keenness of the cutting edge is increased.

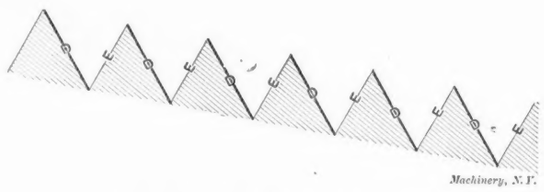


Fig. 3. Section of Threads of Taper Tap.

With the exception of the previous remarks, there is nothing to be said in regard to taper taps which has not already been discussed in these columns in relation to straight taps. (See MACHINERY, June and July, 1907.) As a rule there is not the necessity of the extreme accuracy in taper taps as is sometimes expected from hand taps, because, with incidental exceptions, of course, taper taps are usually employed on work of a rougher character. Besides, being tapered, there is never any requirements for a working fit between the stud and the nut, as the taper taps are used mainly for tapping holes where a water, steam or air-tight fit is required.

TABLE II. NUMBER OF FLUTES OF PIPE TAPS.

Nominal Size of Tap.	Number of Flutes.	Nominal Size of Tap.	Number of Flutes.
$\frac{1}{8}$	4	$1\frac{1}{8}$	6
$\frac{1}{4}$	4	2	7
$\frac{3}{8}$	4	$2\frac{1}{2}$	8
$\frac{1}{2}$	4	3	9
$\frac{3}{4}$	5	$3\frac{1}{2}$	10
1	5	4	11
$1\frac{1}{4}$	6	..	..

Pipe Taps.

The most common of all taper taps is the pipe tap. The shape of the thread for this tap was referred to in the February, 1907, issue of MACHINERY in the article entitled "Screw Thread Systems" under the sub-head "Briggs Standard Pipe Thread." The pipe tap tapers $\frac{3}{4}$ inch per foot, or 1/16 inch per inch, measured along its axis. The taps are known by the nominal size of the pipe for which they are intended; consequently a pipe tap is a great deal larger, measured in inches, than the size by which it is designated. The largest diameter of a half-inch pipe tap, for instance, as seen from Table IV, is 0.887 inch.

Fluting.

Pipe taps are fluted with the same kind of cutters as are used for hand taps. (See June, 1907, issue of MACHINERY.) As there is a considerable difference in the manner in which a hand tap and a pipe tap cut, there is some difference in regard to the required chip room. In the case of a hand tap, as soon as the thread has been cut by the chamfered portion, the straight part of the thread does not cut or produce any chips. The pipe tap, again, being tapered, is constantly cutting, no matter which part of the tap is in contact with the work, and therefore there is a necessity for large chip room, and the flutes should be made as deep as possible without impairing the strength of the tap.

TABLE III. AMOUNT MEASURED ALONG THE TAPERED SURFACE, CORRESPONDING TO ONE INCH ALONG THE AXIS.

Taper per foot.	Amount Measured along the Tapered Surface corresponding to one inch along the Axis.	Taper per foot.	Amount Measured along the Tapered Surface, corresponding to one inch along the Axis.
$\frac{1}{8}$	1.0000	$1\frac{1}{2}$	1.002
$\frac{1}{4}$	1.0001	$1\frac{3}{4}$	1.0025
$\frac{3}{8}$	1.0001	2	1.0035
$\frac{1}{2}$	1.0002	$2\frac{1}{2}$	1.0055
$\frac{5}{8}$	1.0003	3	1.008
$\frac{3}{4}$	1.0005	$3\frac{1}{2}$	1.011
1	1.0009	4	1.014
$1\frac{1}{4}$	1.0015	..	.....

The number of flutes for pipe taps may be approximately determined by the formula:

$$N = 1.75\,A + 3,$$

in which N is the number of the flutes, and A, the diameter at the size line of the tap. This formula gives the number of flutes given in Table II for sizes up to 4-inch pipe tap.

The formula given for the number of flutes makes the distance from cutting edge to cutting edge at the size line larger as the sizes grow larger, thereby making possible deeper flutes in the larger sizes.

Testing Lead of Taper Taps.

In testing or inspecting the lead of taper taps, it must be remembered that the correct lead should be measured on a line parallel to the axis of the tap, and the lead of the thread cannot be measured in the same manner as is done with straight taps, unless due allowance is made for the differences in length along the axis and the tapered surface. In Table III the values are given which should be measured along the tapered surface to correspond to one inch along the axis, for different tapers. In other words, if a tap is tapered $\frac{3}{4}$ inch per foot, and is provided with eight threads per inch, the distance covering 8 threads on the surface of the tap is not one inch but 1.0005 inch, as seen from the table opposite $\frac{3}{4}$ taper per foot. If the lead of the thread is tested by comparing it with a standard tapered thread plug, this need, of course, not be taken into consideration, as then any device for comparing the lead of straight taps is equally applicable to taper taps. The distance on the tapered surface corresponding to one inch along the axis is $\frac{1}{\cos v}$, if v, as before, is determined by the formula

$$\tan v = \frac{t}{2 \times 12},$$

where t is the taper per foot.

Thus, if a tap tapers $1\frac{1}{4}$ inch per foot, and has 8 threads to the inch, if 16 threads were measured at the surface of the taper, the length, if the lead be correct, should not be 2 inches, but 2.003 inch, which we find from

$$\tan v = \frac{1.25}{2 \times 12} = 0.0521.$$

$v = 3$ deg. (approximately), and $\frac{1}{\cos 3 \text{ deg.}} = 1.0014$;

$2 \times 1.0014 = 2.003$ (approximately).

In Tables I and III figures have been given for tapers as steep as 4 inches per foot. Of course, such steep tapers are very seldom encountered.

Dimensions of Pipe Taps.

The dimensions of pipe taps are given in Table IV. Referring to Fig. 4, a dimension *A* is given at the distance *B* from the point of the tap. This diameter is the essential diametral measure of a pipe tap, and the circular line which may be

TABLE IV. DIMENSIONS OF BRIGGS STANDARD PIPE TAPS.

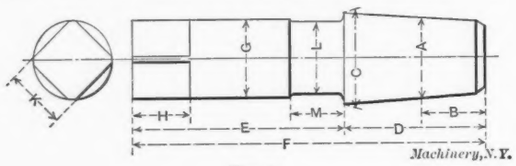


Fig. 4.

Nominal Pipe Size.	Diameter at Size Line.	Distance from End to Size Line.	Diameter at Large End.	Length of Thread.	Length of Shank.	Total Length.	Diameter of Shank.	Length of Square.	Size of Square	Diameter of Neck.	Length of Neck.
	A	B	C	D	E	F	G	H	K	L	M
$\frac{1}{8}$	0.405	$\frac{25}{64}$	0.443	1	$1\frac{5}{8}$	$2\frac{5}{8}$	$\frac{7}{16}$	$\frac{9}{16}$	$\frac{5}{16}$	These sizes have no neck.	
$\frac{1}{4}$	0.540	$\frac{9}{16}$	0.575	$1\frac{1}{8}$	$1\frac{3}{4}$	$2\frac{7}{8}$	$\frac{17}{32}$	$\frac{9}{16}$	$\frac{7}{32}$		
$\frac{3}{8}$	0.675	$\frac{9}{16}$	0.718	$1\frac{1}{4}$	$1\frac{7}{8}$	$3\frac{1}{8}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{9}{16}$		
$\frac{1}{2}$	0.840	$\frac{3}{4}$	0.887	$1\frac{3}{8}$	2	$3\frac{3}{8}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{9}{16}$		
$\frac{3}{4}$	1.050	$\frac{3}{4}$	1.104	$1\frac{3}{8}$	$2\frac{1}{4}$	$3\frac{3}{4}$	$\frac{15}{16}$	$\frac{3}{4}$	$\frac{9}{16}$		
1	1.315	$\frac{15}{16}$	1.366	$1\frac{3}{4}$	$2\frac{1}{2}$	$4\frac{1}{8}$	$1\frac{1}{16}$	$\frac{13}{16}$	$\frac{9}{16}$		
$1\frac{1}{4}$	1.660	$\frac{31}{32}$	1.717	$1\frac{7}{8}$	$2\frac{3}{4}$	$4\frac{5}{8}$	$1\frac{5}{16}$	$\frac{15}{16}$	1		
$1\frac{1}{2}$	1.900	1	1.963	2	3	5	$1\frac{1}{8}$	1	$1\frac{1}{32}$		
2	2.375	1	2.453	$2\frac{1}{4}$	$3\frac{1}{2}$	$5\frac{3}{4}$	$1\frac{7}{8}$	$1\frac{3}{16}$	$1\frac{3}{32}$		
$2\frac{1}{2}$	2.875	$1\frac{1}{8}$	2.961	$2\frac{3}{4}$	4	$6\frac{7}{8}$	$2\frac{1}{4}$	$1\frac{5}{8}$	$1\frac{11}{16}$		
3	3.500	$1\frac{9}{16}$	3.605	$3\frac{1}{4}$	$4\frac{1}{2}$	$7\frac{3}{4}$	$2\frac{5}{8}$	$1\frac{1}{2}$	$1\frac{15}{16}$		
$3\frac{1}{2}$	4.000	$1\frac{5}{8}$	4.125	$3\frac{5}{8}$	$4\frac{9}{16}$	$8\frac{3}{16}$	$2\frac{13}{16}$	$1\frac{9}{16}$	$2\frac{1}{16}$		
4	4.500	$1\frac{11}{16}$	4.629	$3\frac{5}{8}$	$4\frac{5}{8}$	$8\frac{5}{8}$	3	$1\frac{5}{8}$	$2\frac{1}{32}$		
$4\frac{1}{2}$	5.000	$1\frac{7}{8}$	5.125	$3\frac{7}{8}$	$4\frac{11}{16}$	$8\frac{9}{16}$	$3\frac{3}{16}$	$1\frac{11}{16}$	$2\frac{3}{32}$		
5	5.563	2	5.687	4	$4\frac{3}{4}$	$8\frac{3}{4}$	$3\frac{3}{8}$	$1\frac{3}{4}$	$2\frac{1}{4}$		
6	6.625	$2\frac{1}{4}$	6.766	$4\frac{1}{4}$	$4\frac{7}{8}$	$9\frac{1}{8}$	$3\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{13}{16}$		
7	7.625	$2\frac{3}{8}$	7.773	$4\frac{3}{4}$	5	$9\frac{3}{4}$	$4\frac{1}{8}$	2	$3\frac{1}{16}$		
8	8.625	$2\frac{1}{2}$	8.773	$4\frac{3}{4}$	$5\frac{1}{8}$	$9\frac{7}{8}$	$4\frac{1}{2}$	$2\frac{1}{8}$	$3\frac{3}{16}$		
9	9.625	$2\frac{1}{2}$	9.781	5	$5\frac{1}{4}$	$10\frac{1}{4}$	$4\frac{7}{8}$	$2\frac{1}{4}$	$3\frac{5}{16}$		
10	10.750	$2\frac{1}{2}$	10.906	5	$5\frac{3}{8}$	$10\frac{3}{8}$	$5\frac{1}{4}$	$2\frac{3}{8}$	$3\frac{15}{16}$		

These sizes have no neck.

imagined to be drawn around the tap at this point is termed the size line. The two smallest sizes are provided with a neck between the threaded part and the shank. On the remaining sizes the shank is made small enough to come below the root diameter of the thread, and a neck is therefore unnecessary.

As pipe taps must be made according to the established manufacturing standard, formulas for the dimensions cannot be given, excepting for those measurements which are unessential, like the dimensions for the shank and square; but

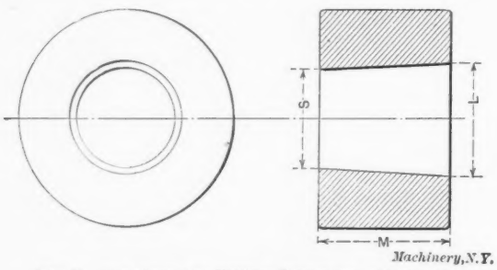


Fig. 5. Ring Gage for Testing Diameters of Taper Taps.

Table IV gives all necessary information in regard to all standard sizes, and formulas, even if they could be given, would consequently be superfluous.

Limits of Accuracy.

The accuracy usually demanded of taper pipe taps in regard to the exact location of the size line is given below. The method of testing or measuring taper taps in order to insure that they are within the permitted limits of variation in this respect is by means of a plain ring gage, as shown in Fig. 5, the diameter *L* at the large end of which is the dimension at the size line; the diameter *S* at the small end of the hole is the diameter at the point of the tap, and the length *M* of the ring gage equals the dimension *B* in Fig. 4, representing the distance from the size line to the point of the tap. Thus, when the tap is tested with this ring gage, if the end of the tap comes exactly flush with the end of the gage, the location of the size line is exactly correct. If the end of the tap projects through, or comes short of the face of the ring gage at the small end of the hole, such projection or shortage represents the error in the location of the size line. The permissible errors are as follows:

Pipe Sizes.	Error Permitted in the Location of the Size Line.
$\frac{1}{8}-1$	$\pm\frac{1}{32}$
$1\frac{1}{4}-3$	$\pm\frac{1}{16}$
$3\frac{1}{2}$ and up	$\pm\frac{1}{8}$

Plus in the above table signifies a projection of the tap through the ring gage, and minus the amount by which the point of the tap fails to reach through the gage in order to come flush with the end of the gage.

* * *

DON'TS FOR MACHINISTS.

W. H. ADDIS.

Don't talk too much.

Don't attempt to bore a taper hole unless the cutting edge of the tool is in line with the centers.

Don't throw in the feed and lead at the same time.

Don't say, "I'll finish this up to-morrow;" earn your money to-day.

Don't believe that every micrometer dial is so graduated that every graduation measures 0.001 inch.

Don't forget to take up lost motion in the feed screws before starting an accurate job.

Don't forget that a little chalk will prevent your file from filling up.

Don't force or jam your turret tools into the work; it is better to sharpen them.

Don't say, "This is good enough"; do it right.

Don't leave oily waste as a collection in the corners. It may cost you your job, and your employer his shop building.

Don't file the cutting edge of a tool to see if it is hard; it may be.

Don't let the emery from the tool-post grinder fall on your lathe ways; newspapers are cheaper.

Don't allow steel chips or filings to become imbedded in your copper vise jaws.

Don't ream a center without using a little oil.

Don't wash a finished screw or bolt with gasoline, and then use it in assembling; gasoline is a poor lubricant.

Don't cut off a piece of work between centers.

Don't stand with your face in line with an emery wheel; the face might get spoiled.

Don't forget to oil the shanks of your turret tools.

Don't forget to measure the rough stock when you receive a job; the stock might be wrong.

Don't forget that a common bottle cork placed over the spout of your oil-can may save you an eye.

* * *

It has been stated over and over again, in the daily as well as in the mechanical press, that fast ocean liners are not directly paying propositions, excepting that, of course, they possess a great advertising value. German periodicals, in particular, have been eager to put forth this theory since the two new Cunarders have taken the blue ribbon of the ocean from the German liners. If a statement, which lately appeared in a Liverpool paper, regarding the expense of running the new Cunard liners is founded on good authority, as it appears to be, fast liners are, however, by no means failures, even from a commercial point of view. According to this statement, the passage money, with the passenger accommodations used to the fullest extent, for a single trip of the *Lusitania* or *Mauretania* amounts to about $140,000, while other incomes from carrying cargo, proportion of ship subsidy, etc., amount to about $16,000. All expenses, including coal, food supplies, harbor dues, insurance, interest, sinking fund, etc., amount to about $90,000. According to this, there should be a clear profit of something like $66,000 on each voyage.

PRACTICAL POINTS ON SURVEYING.*

CHARLES L. HUBBARD.†‡

It frequently happens around manufacturing plants that simple work along the line of surveying is required, such as locating new buildings or extensions, establishing property boundaries, determining grades for drains or steam and return mains, etc. The object of this article is to describe, briefly, the use of transit and level, methods of taking measurements, arrangement of notes, and the plotting of results. No attempt will be made to go into the accurate methods required in important engineering undertakings, as work of this kind is entirely beyond the scope of the present article.

Measurements.

Measurements were formerly made either with a Gunters' or an engineer's chain. The former has 100 links, each 7.92 inches long, making the total length 66 feet, or 4 rods. The handles and the center of the chain are fitted with swivels to

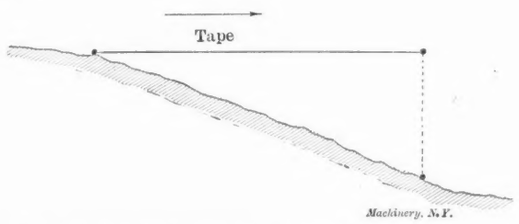


Fig. 1. Method of Holding Tape when measuring over Uneven Ground.

prevent kinking, and at every tenth link from either end is attached a brass tag with one, two, three, or four prongs to assist in measuring. The fifty-link mark is round in form, so it may be easily distinguished from the others. The engineer's chain is similar in construction to the one just described, except the links are one foot long, making the total length of the chain 100 feet. Measurements made with a chain are liable to be inaccurate unless great care is taken, owing to the sagging at the center due to its weight, and also to changes in length caused by wearing at the joints or by the links becoming bent. For the usual work around a manu-

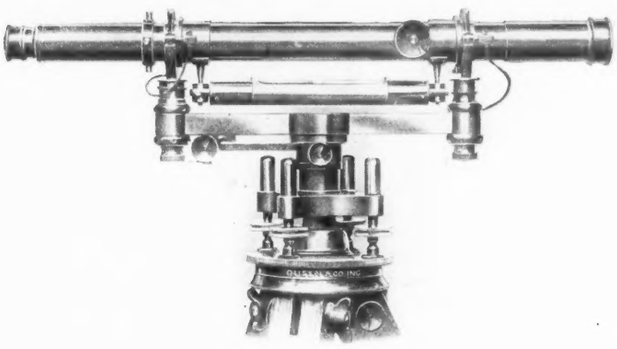


Fig. 2. A Wye Level.

facturing plant a steel tape of good quality, divided into feet and decimals of a foot, is much better than a chain. Tapes of this kind may be had either in 50- or 100-foot lengths. In addition to the tape, there should be provided eleven marking pins. These should be furnished with a strip of red flannel tied into the loop or handle to prevent their being overlooked in the grass.

For measuring a line with a tape, two men, one called the leader, and the other the follower, are required. A stake is driven at the starting point, and another provided with a flag, if the distance is considerable, is set to mark the farther end of the line. The tape is then unrolled in the direction of the line, the 100-foot mark going ahead. The leader takes the pins and the forward end of the tape and walks in the direction of the line, dragging the tape after him. When near the end of the tape, the follower ranges him exactly in line by word or gesture, the tape is drawn taut, the follower holding the end exactly over the starting point, while the leader puts down a pin at the 100-foot mark. This operation is repeated at each tape length, the follower taking up the pins as each measurement is completed. If the line is less than 1,000 feet in length, the distance is determined by counting the pins which the follower has taken up, multiplying the number by 100, and adding the last measurement taken. If a 50-foot chain is used, the number of pins should, of course, be multiplied by 50 instead of by 100. If the line is more than ten tapes in length, the follower should give the pins to the leader when he has collected ten, and a note made each time this exchange is made.

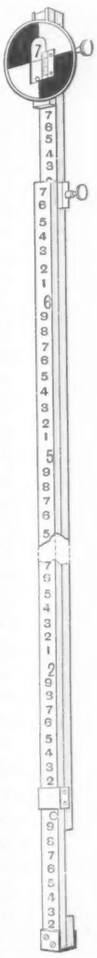


Fig. 3. Leveling-rod.

Since distances used in surveying are horizontal distances, it is necessary that the tape, in measuring over uneven ground, should always be held in a horizontal position. In going down hill, the leader must hold his end of the tape elevated, and in going up hill, the follower must elevate the tape to maintain a horizontal position, as shown in Fig. 1. For ordinary work, the tape is leveled by the eye. If the slope is too steep to permit of one end of a full tape being raised enough to bring it horizontal, the tape is broken, that is, only a part of it is used at each measurement. To do this, the tape should be stretched to its full length, the leader returning to such a point that the portion between himself and the follower may be properly leveled. A measurement is made with this portion of the tape, the operation being repeated with the next section, and so on until the entire tape has been used. The high end of the tape may be transferred to the ground by means of a plumb-bob if great accuracy is desired, but for ordinary work this may be accomplished by dropping a pebble, or a pin with its head down. In measuring up hill, the follower must hold the plumb-bob directly over the pin in the ground while he aligns the leader, and sees that he sticks the pin when the bob is directly over the proper point. It is much easier to measure down hill than up, so that when close measurements are required on slopes, the measurement should, if possible, be made down hill.

Leveling.

Leveling may consist in simply finding the difference in elevation between two points, or, the elevation of a series of points. The former would apply to finding the pressure or head to be obtained at a given point from a pond or reservoir at a higher elevation; or, it might be desired to know the elevation of a steam main above the water line in a boiler located in another building. Again, this applies to the laying out of buildings upon sloping or uneven ground where it is desired to maintain a certain relation between the floor elevations of the different buildings. A series of elevations is required in case of excavation or trenching, in order to determine the depth at different points and the quantity of earth to be removed.

Leveling-rod.

One of the instruments used in leveling is the leveling-rod, a common form of which is shown in Fig. 3. This consists of a wooden rod, usually 6½ feet high, graduated to hundredths of a foot, and provided with a sliding target. The rod is made in two parts, so arranged that its length can be extended to 12 feet. The target is provided with a vernier for accurate work, reading to thousandths of a foot, but the vernier is not often used in the class of work covered by this article. In using, the rod is held in a vertical position with its lower end resting upon the point, the elevation of which is desired, and the target moved up or down until its center coincides with the cross-wires of the telescope of the level.

* See "Surveying without Instruments," by A. L. De Leeuw, July, 1906.

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The reading of the elevation is made from the rod on a line corresponding with the center-line of the target. There are several forms of rods in common use, some of which are read by the rodman, while others are read through the telescope of the level.

The Level.

The instrument usually employed for determining the difference in elevation between points, is called a level. A common form known as the wye level is shown in Fig. 2. It consists of a telescope mounted upon two supports which from their shape are called wyes. The cross-bar supporting the telescope is attached to a vertical spindle which allows it to be turned in a horizontal plane. Directly beneath the telescope, and attached parallel to it, is a spirit level by means of which the line of collimation of the telescope may be rendered horizontal. The telescope is provided with a diaphragm at its focus, consisting of a vertical and horizontal thread or wire. Another instrument in common use is known as the Dumpy level. This is somewhat simpler and more compact than the one just described.

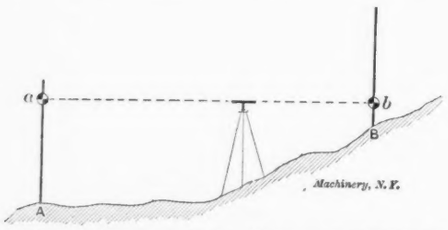

Fig. 4. Finding the Difference in Level between Two Points when the Difference is Less than the Height of the Leveling-rod.

As the various adjustments depend upon the type of level, and as suitable directions are furnished by the makers, only the use of the instrument after it is properly adjusted will be considered. Both types of levels are mounted upon a tripod head and supported upon a tripod. In using the instrument, it should be set up as nearly level as possible by adjusting the legs of the tripod, and then brought to a true level by means of the adjusting screws. To do this, turn the telescope upon its vertical spindle until it is in line with one pair of the leveling screws, then by the proper adjustment of these screws, bring the bubble of the spirit level to the center of the scale; then turn the telescope until it is in line with the other pair of screws, and bring the bubble to the center. Turn back to the first pair of screws, and so repeat the process until the bubble stands at the center of the scale for any position of the telescope in the horizontal plane. The instrument is now ready for sighting upon the leveling-rod.

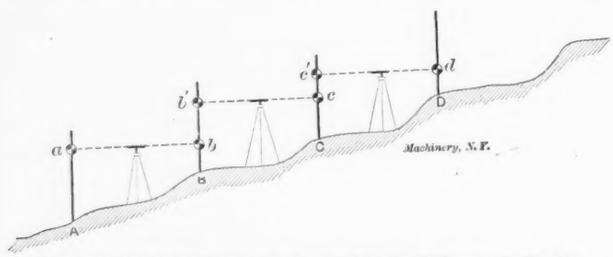

Fig. 5. Finding the Difference in Level when the Difference is Greater than the Height of the Rod.

To find the difference in level between two points which are visible from a third point, is a simple matter. First, set up and level the instrument, as described, at some point approximately midway between the two given points, but not necessarily in line with them. The leveling-rod should now be held vertically upon one of the points (see Fig. 4) and the target moved until its center coincides with the cross-wires of the level, and the reading on the rod taken. This gives the distance $A\,a$. The rod should now be held on the other point B, and the telescope turned upon its spindle and a reading taken with the rod in its new position. This gives the distance $B\,b$, and from the figure it is evident that the difference in level between A and B is equal to $A\,a - B\,b$.

The method just described applies only to cases where the difference in level is less than the height of the rod. Let Fig. 5 illustrate a case where the difference is greater than the height of the rod, as between A and D. First, divide the distance into sections of such length that the difference in level between the dividing points A, B, C, etc., called *stations*, shall be less than the height of the rod. Set up the level between A and B, and measure the distance $A\,a$, called the *backsight;* then reverse the telescope and measure distance $B\,b$, called the *foresight.* Next set up the level between B and C, and measure distances $B\,b'$ and $C\,c$. Repeat the operation with the instrument between C and D, measuring the distances $C\,c'$ and $D\,d$. Referring to Fig. 5, it is evident that the difference in level between stations A and D is equal to the sum of the differences between the intermediate stations, which is

$$(A\,a - B\,b) + (B\,b' - C\,c) + (C\,c' - D\,d),$$

or written in another form is

$$(A\,a + B\,b' + C\,c') - (B\,b + C\,c + D\,d).$$

This shows that the difference in level between two stations is equal to the difference between the sum of the backsights and the sum of the foresights. When the object is simply to determine the difference in level between two points, the above process is all that is necessary, and the only notes required are a record of the foresights and backsights.

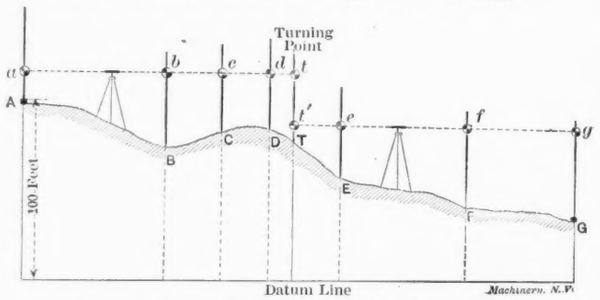

Fig. 6. Finding the Relative Elevations of Several Points.

When it is desired to find the relative elevations of several points, as in grading or trench work, it is necessary to keep more elaborate notes, and to measure the distances between the stations. The first step is to assume a datum line which shall be below the lowest point in the contour, and to refer all elevations to this line. It is also customary to start the line at some fixed mark which cannot be easily disturbed, such as the corner or top of a rock, the stump of a tree, a mark on a building wall, or the top of a hydrant, etc. This is called a bench-mark. In Fig. 6 let A be a bench-mark, and let us assume a datum line 100 feet below the level of the bench-mark A. The field notes corresponding to the operations shown in Fig. 6 are given in Fig. 7. Starting with the instrument between A and B, and taking a backsight on A, we find the distance $A\,a$ to be 4.2 feet, which added to 100 gives the height of the instrument. We next take foresights on B, C, and D, and record them in the proper column. It is evident from Fig. 6 that readings $B\,b$, $C\,c$, etc.,

Station.	Distance.	Backsight.	Height of Instrument.	Foresight.	Elevations.	Remarks.
A	0	4.2	104.2	.....	100	Bench-mark, top of hydrant.
B	100	....	.....	10 1	94.1	
C	60	.....	.....	7.3	96.9	
D	50	.....	.....	5.8	98.4	
T	.....	4.1	99.1	9.2	95.1	Turning point.
E	70	6.8	.....	.....	92.3	
F	110	.....	.....	9.5	89.6	
G	80	.....	.....	11.5	87.6	

Fig. 7. Field Notes corresponding to the Operations illustrated in Fig. 6.

subtracted from the height of the instrument will give the elevation at B, C, etc. This is done, and the results recorded in the proper column. The ground falls away so rapidly beyond D that it is necessary to set up the level further along and establish a new height of instrument. This is done by holding the rod at some convenient point as at T, called a *turning point*, and taking a foresight, which measures the

distance $T\,t$ (9.2). The level is then set up in its second position between E and F, and a backsight taken on the rod in the same position which gives the distance $T\,t'$ (4.1). Then the distance $t'\,t = 9.2 - 4.1 = 5.1$, and this subtracted from the previous height of instrument gives the new height which is $104.2 - 5.1 = 99.1$. A backsight is now taken on E, and foresights on F and G. These are recorded in the proper columns, and the elevations found by subtracting these distances from the new height of instrument.

The horizontal distances between the stations are measured with a tape as already described, and recorded in the second column. In plotting a cross-section from notes kept in this way, the datum line is first drawn, and perpendiculars erected at points corresponding to the different stations. The proper elevations are then indicated on these vertical lines, and a contour-line drawn through the points so marked.

The Transit.

The transit (see Fig. 8) is an instrument for measuring both horizontal and vertical angles, although for ordinary

Fig. 8. Transit used for Measuring Horizontal and Vertical Angles.

work the vertical attachment is omitted. This instrument consists of a telescope mounted in standards which are attached to a horizontal plate called the *limb*. Inside of the limb, and concentric with it, is another plate called the *vernier-plate*. The lower plate or limb turns on a vertical spindle or axis which fits into a socket in the tripod head. By means of a clamp and tangent-screw, shown in the figure, it may be clamped fast in any position, and made to move slowly through a small arc. The circumference of this plate is usually graduated in divisions of either one-half or one-third of a degree, and in the common form of transit these divisions are numbered from some one point on the limb in both directions around to the opposite point which will be 180 degrees. The graduation is generally concealed beneath the plate above it except at the verniers. This upper plate is the vernier-plate, which turns on a spindle fitted into a socket in the lower plate. It is also provided with a clamp by means of which it can be held in any position, and with a tangent-screw by which it can be turned through a small arc.

A vernier is a device for reading smaller divisions on the scales than could otherwise be done. The method of reading a vernier is shown in Figs. 9 and 10. The lower scale represents a portion of the graduations upon the limb, and the upper scale, the graduations of the vernier. In Fig. 9 the vernier is set at zero, and in Fig. 10 the vernier-plate has been revolved through a certain angle which we wish to read. Looking at the pointer at the extreme right of the

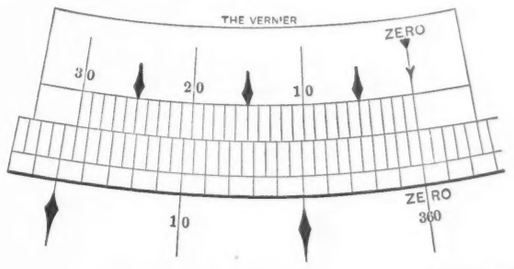

Fig. 9. The Vernier set at the Zero Mark.

vernier, we see that it stands between 20 and 20½ degrees on the lower scale. We next follow along the vernier until we find a division which is exactly in line with one on the lower scale; this we find to be 10 on the vernier, therefore, the reading is 20 degrees and 10 minutes. A vernier reading to minutes is sufficiently accurate for ordinary work.

The transit shown in Fig. 8 is provided with a compass so that the bearing of any given line with the magnetic meridian may be determined if desired. It also has a spirit level attached to the telescope so that it may be brought to a horizontal position and made to serve as a level. Fig. 11 shows an instrument known as the *architect's level*. This is a level with a short telescope, and is provided with a graduated circle and vernier for measuring horizontal angles. It is a very useful instrument for simple work, such as laying out buildings, etc., where great accuracy is not required. The transit requires various adjustments, a description of which may be had from the makers.

To center the transit over a stake, rest one leg of the tripod upon the ground, then grasp the other legs and place the instrument as nearly over the stake as possible. Then attach the plumb bob and center it accurately by means of the shifting head. Avoid having the plates too much out of level, as this will result in unnecessary straining of the leveling screws and plates. Having centered the instrument over the stake, level it up by the spirit levels upon the horizontal plate. To do this, turn the instrument upon its vertical axis until the bubble tubes are parallel to a pair of diagonally opposite plate-screws. Then, as you stand facing the instrument, grasp the screws between the thumb and forefinger, and turn the thumb of the left hand in the direction the

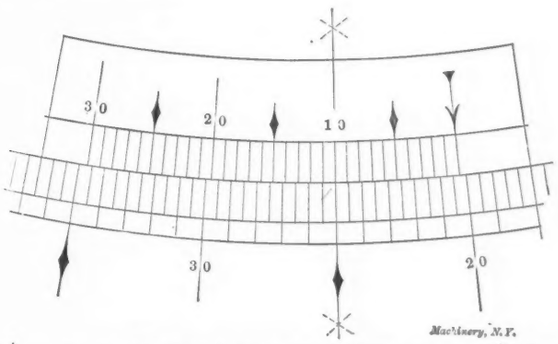

Fig. 10. The Vernier set 20 Degrees and 10 Minutes from the Zero Mark.

bubble must move. When adjusting the screws, turn both thumbs in or out, never in the same direction. Adjusting one level will disturb the other, but each must be adjusted alternately until both bubbles remain constant.

To measure an angle as between the lines $A\,B$ and $A\,C$ (Fig. 12), set up and level the instrument at A as already described, and clamp one of the verniers at the zero mark on the circle. Turn the telescope upon the target at B, and clamp the limb.

Unclamp the vernier-plate, and turn the telescope upon the other target at *C*. Read the vernier which had been set at zero, and the reading will be the horizontal angle through which the telescope turned from *B* to *C*. It is not necessary to set the vernier at zero before pointing at the first target The result will be the same if the vernier is read when pointed at the first target, and then again, when pointed at the second. The difference between the two readings will be the angle required. Care must be taken in this method to note if the vernier passes the 180 degree mark, and if so, to make the proper calculations. For simple work where there are but few angles to be measured, it is less confusing to set the vernier at zero each time, especially for those not experienced in the work.

The process of laying off a given angle is similar to that of measuring an angle. The transit is set up at the vertex

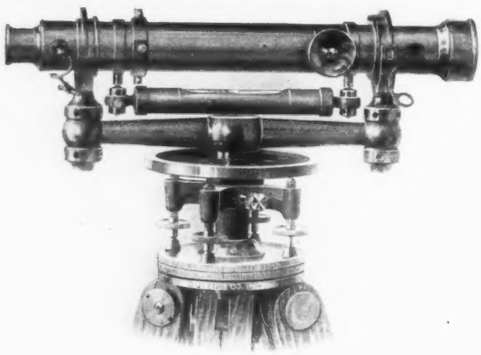

Fig. 11. Architects' Level.

of the angle, the vernier clamped at zero, and the telescope pointed at the target marking the direction of the fixed line. The limb is now clamped, the vernier unclamped, and the vernier-plate turned through the desired angle and clamped. A stake should now be driven in line with the vertical wire in the telescope, thus establishing the two sides of the angle.

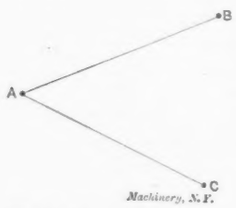

Fig. 12. Measuring a Horizontal Angle.

In laying out the foundations of buildings, a corner stake is first located by measurement, then the direction of one of the walls is laid out by driving a second stake. This direction may be determined by local conditions, such as the shape of the lot, or the relation to other buildings. If the building is to be an extension to, or in line with another building, the direction can be obtained by sighting along the building wall and driving two stakes in line with it. If it is to make a given angle with another building, this angle can be laid off as shown in Fig. 13. After the corner and the direction of one wall are determined, a right angle may be laid off (if the building is rectangular), thus locating two of the sides,

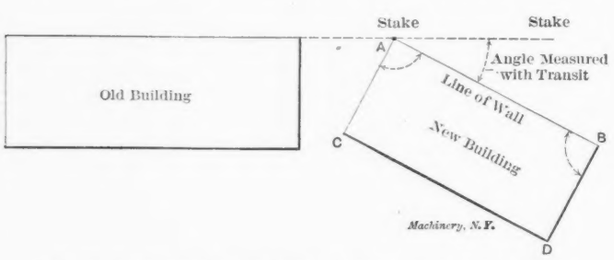

Fig. 13. Laying Out One Building at a Given Angle with Another.

as *A B* and *A C*. The length of the side *A B* is now measured, locating the corner *B*. The transit is now set up at *B*, and the line *B D* laid off at right angles to *A B*. *A C* and *B D* are then laid off the proper length, and thus the four corners of the building located. If the building had not been rectangular, the proper angles could have been laid off instead of right angles.

It is often desirable to make a block plan or map of the grounds and buildings of a plant. In Fig. 14 is shown the general method of plotting an irregular street or road, and of locating buildings with reference to it. First, locate a series of stations along the center of the street as *A*, *B*, *C*, etc. Then set the transit up at *B* and measure the angle *A B C*. Also measure the angle *A B N* by means of the compass which

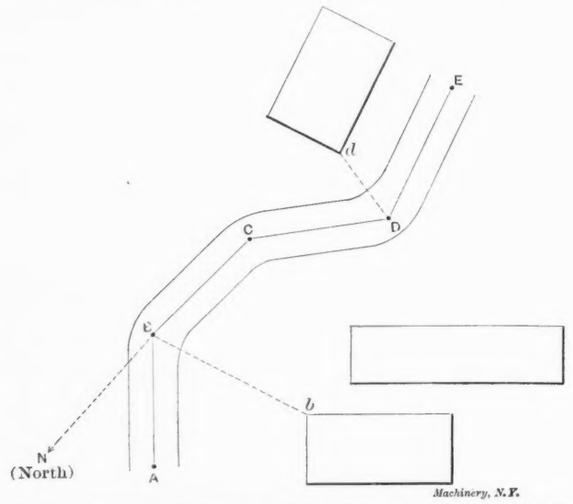

Fig. 14. Method of Plotting an Irregular Street or Road, and obtaining the Relative Positions of Adjacent Buildings.

is usually furnished with a transit, thus establishing the bearing of the line *A B* with the points of the compass. While the transit is at *B* the angle *A B b* should be measured, which, with the distance *B b* will locate the corner of the building. The direction of the building wall can be determined by continuing the direction of one of its sides, and measuring the angle between it and the magnetic needle of the compass. The instrument may now be set up at *C* and the angle *B C D* measured; also set up at *D* and the angle *C D d* measured, which locates the corner of the second building. Angle *C D E* is then measured in a like manner. All distances between stations should be measured by means of a tape.

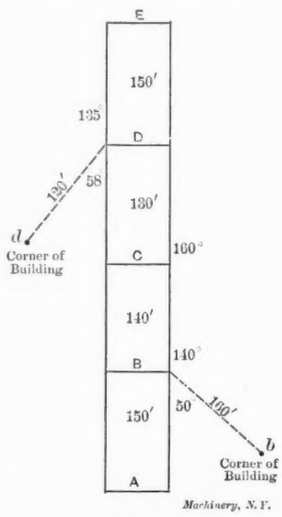

Fig. 15. Method of Keeping Notes for the Survey Illustrated in Fig. 14.

The method of keeping the notes for the above survey may be as shown in Fig. 15. The different stations are represented by *A*, *B*, *C*, etc., and the distances between them are noted between the vertical lines, as 150′ 140′, etc. With each change in direction, the angle made by the preceding line is noted outside of the vertical column, and on the side which the line turns. For example, *B C* makes an angle of 140 degrees with *A B*, and turns toward the right; *E D* makes an angle of 135 degrees with *C D*, and turns toward the left. The line locating the corner of building at *b*, is measured from station *B*, and makes an angle of 50 degrees with *A B*. In plotting a map from the notes, the distances are measured off to a suitable scale, and the angles laid out by means of a protractor.

* * *

It is not too broad a statement to make, that it is of the utmost importance that every young engineer should from the start develop for his own use a system of record keeping of the information which he may use in his professional work and of the facts connected with the design, construction, maintenance, and operation of the plants, machinery, etc., with which he is connected.—*H. M. Brinckerhoff, in Stevens Institute Indicator.*

ON THE STATE OF THE PATENT OFFICE.

H. ADDISON JOHNSTON.*

If a prospector discovers gold-bearing rock on unclaimed land in the United States, he can, by doing certain things prescribed by law, secure to himself, his heirs and assigns, *forever*, the exclusive right to mine the gold that he has discovered. What he has discovered is *his* property.

If an inventor discovers (or invents) a new and useful combination of elements, in unclaimed ground in the United States, he can, by doing certain things prescribed by law, and *paying a considerable sum of money*, secure to himself, his heirs and assigns, *for seventeen years only*, the exclusive right to manufacture the invention that he has made. What he has discovered (or invented) is *his property*, but the government makes this bargain: "If the inventor will fully describe and make known his invention, and give it to the public after seventeen years, then the government will provide punishment for anyone who tries to steal the invention during the seventeen years, provided, however, that the inventor must himself catch the thief and prove his guilt.

What would be the result if the government passed a law that all the gold mines, the homesteads, and the coal fields were to be thrown open to the general public after seventeen years? Yet this is what happens to patented inventions.

Now, I do not wish to be understood as advocating an extension of the life of a patent; the point I wish to make is this: A man's invention is as truly his own property as is his house, or clothes, or farm; no one else has any right to it. Hence, in justice, there should be no attempt made to collect heavy fees from the inventor for the purpose of paying the expenses of the patent office. The country is benefited many times the cost of the patent by the mere fact of the invention being made and, in any case, if the government takes away his invention at the end of seventeen years, it has then much more than obtained value for any expense to which it may have been put in issuing the patent.

The present United States patent office stands in greater need of reorganization than any other institution with which I have had the misfortune to do business. It is safe to say that were any commercial firm to conduct its business with no greater regard for the satisfaction of its customers than the patent office shows in its treatment of applicants, it would close its doors in less than six months. A general criticism is productive of nothing but hard feelings, hence I proceed to details.

1. The whole story of the obtaining of a patent is delay, delay, delay. When an application is sent in it is delayed from a few weeks to several months before it is acted upon. When it is amended, another delay, and amendments and delays follow each other indefinitely. If the delays were eliminated many of the other sources of dissatisfaction could be borne with.

2. When an examiner makes citations against a case, instead of searching thoroughly and bringing out all the references to be had, either through lack of time, incompetence, or what not, he cites only two or three references. When the patent claims are amended so that the references are avoided, and the inventor expects the patent to be allowed on the next actions, instead, after a long delay, he gets two or three more references. This process may be repeated several times.

3. References are cited against applications which have no bearing on the case; when these references are shown to be irrelevant, they are dropped and new citations made which may have no more bearing on the case than the old ones. After each action there is a long delay. No other cause can be shown for this state of affairs than incompetence in the examiner. An examiner should be so familiar with the work of his class that it would be impossible for him to mistake the bearing of other inventions on the one in hand.

4. There is apparently no special examination made as to the ground covered by an application when it is first received. It is a most aggravating experience, after waiting several months for action on a case which has been amended several times to suit the office, and for which notice of allowance is expected, to receive an official communication asking for division of the application, and to find that nothing whatever has been done as to the merits of the case. This may cost the inventor six months of valuable time, and the worst feature of the case is that there is absolutely no reason for any lost time at all. Action as to the merits of the case need not be suspended just because division is required.

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5. Misleading information is published in the *Patent Office Gazette*. For instance, it may be stated in the *Gazette* that on February 1 in a certain class the oldest amended application awaiting action bears filing date of August 1 of the year previous. The applicant may have sent his amended application to the office many weeks before August 1 yet no action has been taken on his case. I have been unable to explain this discrepancy and it is exceedingly unfortunate that it should exist.

6. Copies of patents are allowed to run out. Surely it would be as easy to replenish the stock of copies just before the supply is exhausted as it is a month after.

It is not generally realized how much the present condition of the patent office operates to favor the large industrial corporations at the expense of independent inventors. A company that is already established and has its product on the market is continually taking out patents on improvements in its methods and manufactures. The longer such patents are delayed in issuing the better pleased is the company, for its mark "Pat. applied for," gives plenty of protection at first, and the effective life of the patent is lengthened by the time taken to have it issued. Patents have been purposely delayed in issuing for years for this very reason.

On the other hand the independent inventor needs his patent just as soon as he can get it. In 99 per cent of the cases he must obtain outside capital to develop his invention, and his only resource for so doing is his patent. When the patent is delayed, the inventor either has to stop work for lack of cash or is driven into hard bargains to obtain money to live.

Although justice demands that patents should be issued promptly, and to all alike, yet it has often seemed that a much more satisfactory method than the "general delay" practice now in use would be to give prompt action to those who requested prompt action, and delayed action to those who wanted delay or were indifferent. [We would emphatically object to delayed action in any case, because of the abuses fostered by delays.—EDITOR.]

After criticism of existing conditions, suggestions for betterment are in order, and I would suggest:

1. That the commissioner of patents be authorized to secure *sufficient* assistance in the patent office so that no application will be awaiting action more than ten days in any class.

2. That examiners be instructed to cite as nearly as possible all references upon the first action. The practice of continually bringing forward new references should be strongly condemned, and any examiner who constantly follows this practice should be deemed incompetent. In certain cases new references will naturally be found, but as a general principle the foregoing should apply.

3. That it should be deemed evidence of incompetence on the part of an examiner to cite references which have no bearing upon the case in point. The continual dropping of references upon explanation of the inventor and the citing of new ones is entirely unnecessary, and could be avoided by care on the part of the examiner.

4. That an examination as to correctness of form and ground covered by an application should be made immediately upon receipt of the application. If an examiner calls for the division of an application after one or two actions on the merits of the case, he should be made to pay the additional fees himself.

5. That the commissioner of patents be instructed to see that no further misleading information with regard to the amount of time the office is behind its work, is published in the *Gazette*. There is no reason why correct information cannot be given.

6. That a clerk be appointed to see that the stock of printed copies of patents is not allowed to run out. It is just as easy to start printing when there are 5 or 10 copies left, as to wait until some one has ordered a copy after the stock is exhausted.

7. That all the claims of a patent be printed in the *Gazette*. The recent decision to print only five claims of a patent in the *Gazette* seems to be extremely unwise. The value of the *Gazette* as a book of reference lies in its completeness. Printing the *Gazette* with claims missing all through it, would be on a par with publishing a novel with pages left out here and there. If it costs too much to sell it at its present price, raise the price, but publish all the claims.

8. That, if possible, a department of search be instituted at the patent office to make search of the records for intending patentees, at cost.

9. That the commissioner of patents be made a "general manager" with full authority to spend whatever money may

be necessary to get results, and that he be instructed to get results no matter at what cost. Would any man with common sense place an employe in charge of a business with these orders: "All business must be taken care of, no matter what the increase;" "The staff must not be increased nor any money spent except on postage, express and paper;" "Take in all the money offered; if the customers complain of delays, tell them it costs us nothing to wait"?

I have before me copies of Mr. Pratt's bills, H. R. 6173 and 6228 *re* patent office, one to increase the staff and salaries of examiners at the patent office, the other to increase the fees. I am certainly in favor of increasing the staff, and the efficiency of the staff, of the patent office, and, if it is necessary to increase the salaries to get competent men, by all means do so, but get them.

In regard to fees, as I look at the matter the fees should be kept at a merely nominal figure, say $25, or at just sufficient to keep down the number of applications for patents on inventions of little or no value. If the government absolutely refuses to consider the matter in this light and insists upon the office being self-supporting, then the funds should be obtained, not by raising the initial fee, but by requiring increasing license fees to be paid as the years pass. Let them be, say $25 for the third year, $50 for the fourth, $75 for the fifth, and $100 for the sixth, and succeeding years.

The independent inventor is an asset to the country and should be encouraged. Generally he finds money very hard to get at first. If his invention is worth anything by the time the third year is reached he will be able to pay the fees, if not, he can allow the patent to lapse without further loss to himself. The country does not lose anything in any case.

Since writing the above, the last report of the commissioner of patents has reached me, and in it some very interesting information may be found. I quote from it:

Over 56,000 patents applied for last year.

Total surplus to credit of patent office, January 1, 1908, $6,706,181.64.

Surplus last year, $275,000.

After stating that the force of examiners is not sufficient, and that more room is needed, and that part of the building now occupied is not suited for the work, he states:

"Examiners frequently work overtime to try to catch up with their work *in order that a good showing might be made before Congress met.* Their efforts under these conditions were at best spasmodic, and simply resulted in thousands of actions being made that were nothing more than frivolous. After one of these annual efforts it was necessary to do a greater portion of the work all over again, and it really had the effect of throwing the business of examination further back than ever. This resulted not only in vexatious delays to the inventors, but it caused hundreds of complaints to be filed, and what was still more embarrassing and serious, a great many applications were passed to issue that were not ready for patent, with the result that the inventors and owners of meritorious inventions forfeited valuable rights by these careless, ill-considered and hasty actions on the part of the office.

"The inventors are entitled to be protected as well as the public, and they should be helped by the office in all legitimate ways.

"The inventors pay the government for the work done in the examination and issue of their patents.

"Complaints against the conduct of affairs have been numerous and many have been based upon good and sufficient grounds. The affairs of the office should be so conducted that very few if any complaints could be lodged.

"I am most decidedly of the opinion that the present force cannot cope with it (the increased business of the patent office), and I have asked for a sufficient number of examiners and clerks to bring the arrearages up to date and to dispose of the great amount of increasing work material.

"If the force asked for is granted and made immediately available, I believe that the accumulated work can be disposed of, and that it will be possible in the future for the average inventor's application to be acted upon and either rejected or a patent allowed within thirty days of its receipt.

"The inventors are entitled to prompt action and they should be accorded it.

"The incompetency of a portion of the clerks in the examining and other divisions is in a measure responsible for the backward condition of the work."

The commissioner states that as soon as a man is well broken in to his work, he is offered more than the office is allowed to pay, to go to outside work. This is a fine (?) way to supply good patent attorneys for large corporations. The inventors pay for their education, and when they are worth something they move out. In the name of common sense, let the patent business be conducted in a businesslike way, which manifestly is not the present practice.

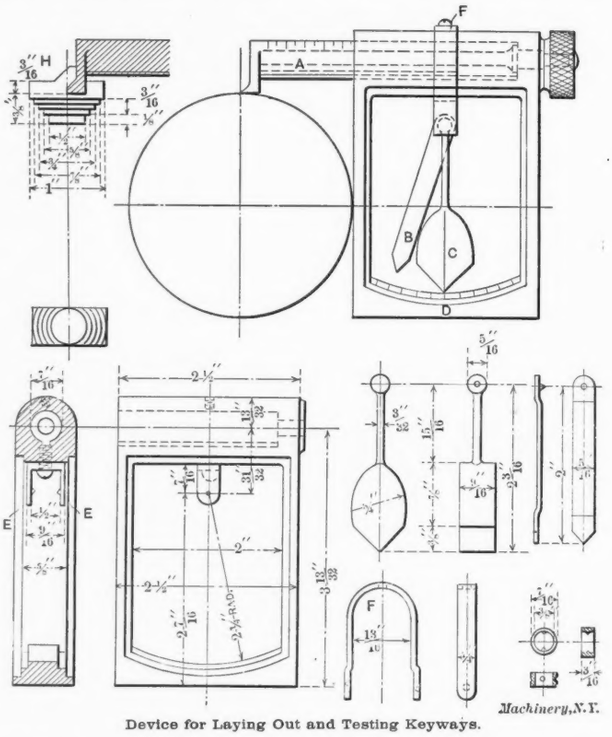
If proof is required as to the truth of my statements the report of the commissioner gives quite sufficient confirmation. The question is: "What are we going to do about it?"

* * *

DEVICE FOR LAYING OUT AND TESTING KEYWAYS.

W. O. RENKIN.

The accompanying cut shows a device which can be used either for checking the location of keyways already cut, or for locating the center line for keyways on shafts. Its particular usefulness comes into evidence when it is wanted to check the location of keyways at different parts of long shafts, the procedure of which is as follows: First, have the shaft lying free, but not necessarily level, and then place the side of the device against the shaft and the point of the bar *A* in the keyway, and set the indicator *B* directly over the center line of the plummet *C*. When the device then is moved to



Device for Laying Out and Testing Keyways.

different parts of the shaft, if the keyway is placed exactly in the center at each point, the plummet end and the indicator retain their relative positions. When it is wanted to locate the center line on shafts for cutting keyways, the bar *A* is screwed out until the point is located exactly one-half the diameter of the shaft from the side of the device, and then, with the shaft lying on a planer table or bed plate, adjust the device further until the plummet hangs directly over the center mark at *D*, after which the center of the shaft may be marked and the device moved to another point. As will be noticed from the detailed drawings shown, the body of the device has a recess on each side at *E*. This recess is intended for holding a thick piece of glass enclosing the plummet on the sides. The indicators are placed one on each side of the device, resting against the glass and held up to it by the saddle *F*. This permits the device to be used from either side. At *H* are shown different size "feet" for the center bar *A*. The writer believes that this is the only tool so far designed which can be readily used for this work without necessitating that the shaft be first levelled up.

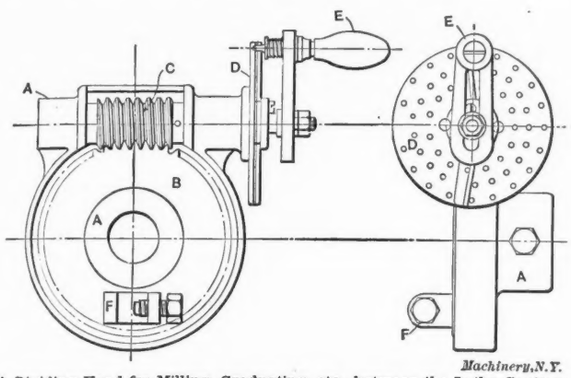
* * *

It is stated by the *Practical Engineer* that out of 824,000 tons of manganese used in this country, Great Britain, and Germany, during 1905, over 90 per cent was used for alloy steels.

ITEMS OF MECHANICAL INTEREST.

DIVIDING HEAD FOR USE WITH THE LATHE.

Occasionally it is necessary to do on the lathe a piece of work that requires dividing. If there is no milling machine in the shop, the lathe is sometimes rigged with a milling spindle on a knee attached to the carriage, for operating on work between centers. If a gear, for instance, is to be cut in this way, the question of indexing is often somewhat puzzling. If the number of teeth desired is a factor of the number of teeth in the main spindle driving gear, this may be used for indexing. If not, other more cumbersome methods have to be devised. The apparatus shown in the accompanying engraving is intended to give the lathe for such work, nearly as great facility as is offered by the milling machine



Machinery,N.Y.

A Dividing Head for Milling, Graduating, etc., between the Lathe Centers; it is mounted on the Tail-stock Spindle.

with its dividing head. This device, which is patented, was illustrated in a recent issue of *Machines Outils et Outillage*, of Paris.

The main casting *A*, of the attachment is fastened, by the set-screw shown, to the tail-stock spindle. On the front side it is provided with a projecting hub which forms a journal for dividing worm-wheel *B*. The main casting encloses this wheel in a guard, and on its upper side is provided with bearings to support the shaft on which the worm *C* is mounted. The worm shaft is controlled by the adjustable crank *E*, having a pin entering holes in index plate *D*, substantially as arranged for the milling machine dividing head. The usual adjustable sectors are provided. The work, which is supposed to be mounted on centers, is driven by a dog whose tail is engaged in clamp *F*, bolted to the face of the index wheel *B*. It will readily be seen that any desired spacing can be given to the work thus mounted, by operating the index handle in the same way as in the milling machine.

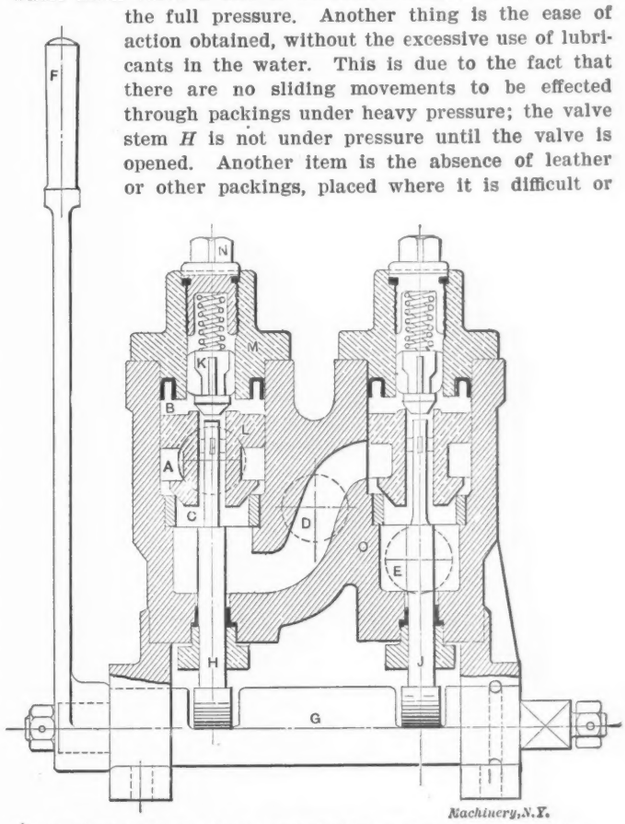
HYDRAULIC VALVE OF ENGLISH DESIGN.

A catalogue recently received from an English firm, Dewhurst's Engineering Co., Ltd., of Sheffield, describes a design of hydraulic valve for high pressures and large volumes that is ingenious enough to warrant some attention. A cross section of the valve is shown in the accompanying line engraving. In the case shown, there are two valves with an inlet at *A*, a connection at *D* for the hydraulic cylinder to be operated, and an outlet at *E*. These valves are operated by handle *F*, connected to rock-shaft *G*. Throwing *F* in one direction opens the inlet valve at *A*; throwing it in the other allows the water to escape from *D* through outlet at *E*.

The valve stems *H* are raised by cam surfaces cut in the upper side of rock-shaft *G*. The stems do not directly open the main valves; the upper end of a stem passes through main valve *L* in a hole large enough to allow it plenty of clearance, as shown, and when raised, it strikes against the bottom of pilot valve *K*, which it lifts against the pressure of the spring above it and against the pressure of the water in chamber *B*. Chamber *B* is filled with water leaking from inlet space *A*, past the easy fit of the piston portion of valve *L* between them. As soon as *K* is raised, the pressure in *B* rapidly drops to that in service connection *D*, since the outlet through the center of the main valve is much larger than the area through which the leakage escapes from *A*. Under these circumstances there is an unbalanced pressure on valve *L* from the water in *A*, which forces it from its seat on ring *C*. This unbalanced pressure is obviously due to the fact that the piston portion of main valve *L* is much larger in diameter than the seat on which it rests in ring *C*.

In closing, the reverse of this action takes place. Handle *F* being brought back to its central position, valve stem *H*, and with it pilot valve *K*, are lowered until the latter reaches its seat in valve *L*. Connection between *B* and *D* being thus closed, the leakage from *A* into *B* allows the pressure in the latter space to rise until it balances that in *A* when the coil spring has sufficient pressure to force valve *L* down against its seat. The two valves are identical in construction and operation.

This construction evidently has a number of advantages. The use of the small pilot valve, the only member which has to be lifted against the full pressure of the water, makes the apparatus more easy to handle than would be the case if the whole main valve *L* had to be raised from its seat against the full pressure. Another thing is the ease of action obtained, without the excessive use of lubricants in the water. This is due to the fact that there are no sliding movements to be effected through packings under heavy pressure; the valve stem *H* is not under pressure until the valve is opened. Another item is the absence of leather or other packings, placed where it is difficult or



Machinery,N.Y.

A Hydraulic Valve which is controlled by the Operation of a Small Pilot Valve.

impossible to detect leakage past them. Packing is provided for plug *N*, cap *M* and valve rod *H*. All of these, it will be seen, pack against the atmosphere. It will also be noted that both the main and pilot valves can be easily reground without breaking any of the hydraulic joints. There would appear, also, to be little danger of shock from sudden closing of the valves, since the lowering of main valve *L* to its seat on *C* is effected by the leakage from *A* to *B*, which can be made as gradual as seems advisable, being regulated by the fit of *L* in its cylindrical chamber in main casting *O*.

* * *

Once in a while we find the idea cropping up of using an impeller instead of a propeller for driving a ship. In other words, the jet propulsion idea is one that inventors seem to still worry about. The jet or hydraulic propulsion has, however, been tried a great many times with very little success. The trouble seems to be the low efficiency of the pump or impeller, the combined propulsive efficiency of which is far below that of the screw propeller. The constant failures of many inventions seem to indicate that jet propulsion, like rotary steam engines, belongs to a class that are more interesting to the ingenious inventor than useful to the practical shipbuilding engineer.

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MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

49-55 LAFAYETTE STREET, CORNER OF LEONARD,

NEW YORK CITY.

Alexander Luchars, President and Treasurer.

Matthew J. O'Neill, Secretary.

Fred E. Rogers, Editor.

Ralph E. Flanders, Erik Oberg, Franklin D. Jones, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MARCH, 1908.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE RECOGNITION OF ABILITY.

From an interview with President Nash of the Corn Exchange Bank of New York, published in a recent Sunday issue of the *New York Times*, we quote the following:

"Too many of our young men seem to lack distinction, originality of thought—I might say initiative. In a word, they do not think for themselves, and make suggestions. I know how it is here in the bank. We have a number of young men who are capable, intelligent fellows. They do their work in a satisfactory way. Yet they do not come forward with new ideas. That is the thing a modern business man is always seeking in an employe. I know we are always glad to get them. We may not follow the suggestions, still the ideas are welcome."

We do not wish to put ourselves in the position of criticising Mr. Nash, who is a man of great ability and strong character; but it is not going too far to say that the sentiments he expresses, though superficially true, are radically false, as thousands of men of suppressed ability can testify. One would think from the banker's language that men in authority are always eagerly sensitive to the slightest sign of originality in the ranks of their subordinates. In reality this is so only in exceptional cases. In the first place, the commanding officer is often temperamentally unfitted to recognize ability in a subordinate. It is one of the rarest qualities of genius to be able to do this, and instead of seeking new assistants, most captains of industry have to be content with using, to the limit of their capacity, the men whom chance and natural aptitude combined, have brought to responsible secondary positions. Besides this, even though the leader may have this power of recognizing genius, there must necessarily be so great a gulf fixed between him and the private that it is only by some stroke of good fortune that the latter ever comes in contact with his superior at all. Even though he may persistently seek that contact, he has still to pass the high and wide barrier of arrogance and petty jealousy erected by secondary officials.

There is most certainly a fortuitous element in success. There are many men of the class of our banker, but without his unusual ability and character, who have been carried into power and place by the swelling tide of our national development, nothing more having been required of them than the ordinary common sense and application daily exhibited by tens of thousands of their less fortunate brothers. Where, for instance, are the life insurance presidents of yesterday, whose great ability (we were told) was the cause and justification of the enormous salaries they received? After the storm which swept these men from their lofty positions, down to the level where men compete with one another on the hard, cold terms under which such competition rages in our times, these men were never heard of more. Their places are acceptably filled by other men with smaller salaries, and who doubts but that there are scores yet left who could replace the present incumbents if they should step from their positions?

This fortuitous element in success is one of the most discouraging things the young man has to face. In "Captain Stormfield's Visit to Heaven" Mark Twain causes the narrator to discover that the other world is a place where men are rewarded according to their real ability, and not according to their earthly reputations. He found, for instance, that the greatest general in Heaven, to whom Napoleon, Cæsar, and Alexander bow in humble reverence, was an East Boston cobbler who lived during the Revolutionary War. He had in him a military genius the like of which the world has never seen. He tried again and again to enlist as a private, but was refused each time, owing to the fact that he had lost his trigger finger. Most young men are not content to wait for Heaven to have their abilities recognized, and they would chant an earthly hymn of praise to the wise counselor who would give definite, positive, practical information on the question of the successful marketing of ability. Let us have something of this kind, in place of the conventional lament over the lack of originality and initiative in the decadent generation to which we belong.

* * *

THE WIVES OF OUR READERS.

It may seem a trifle inquisitive, but we must admit that we are vitally—because pecuniarily—interested in the wives of our subscribers. As nearly as we can figure it out, a large proportion of the readers of MACHINERY are young men. Along about twenty-two years of age or thereabouts the normal young man is beginning to think quite seriously of the possibility of supporting a wife in the style to which she has been accustomed. He has perhaps had difficulty supporting himself on the salary he has been receiving, and the prospect seems almost hopeless for two. A condition of this sort is a powerful spur to ambition, and MACHINERY and other technical papers, as well as scientific text-books and the correspondence courses, all play their part in assisting the desperate youth to a better livelihood.

In too many cases the effort is a spasmodic one, never repeated; and this is often the fault of the wife. There are exceptional men, of strong enough personality to sink or swim independent of the influence of the other half of the family; but made up as most of us are, the need for courage and ambition in the wife is a vital one. As the man gets along toward middle age and loses the exhilaration of high animal spirits, the possibility of progress seems to be dependent on efforts which become more and more difficult. Take the simple matter of subscribing to MACHINERY, for instance. With a house full of children to feed and clothe, there seems to be a need for every available dollar that can be brought into the family, and the few luxuries have to be carefully planned for. Under such circumstances we can imagine the wife saying "Why do you keep spending money for that old MACHINERY? Why don't you get something we can both enjoy?" And thus MACHINERY and the machinist alike are foully dealt with.

There is a moral to this, which we leave those of our readers who are contemplating matrimony to discover.

* * *

The man who is worthy of being a leader of men will never complain of the stupidity of his helpers, of the ingratitude of mankind nor of the inappreciation of the public. These things are all a part of the great game of life, and to meet them and not go down before them in discouragement and defeat is the final proof of power.—*Elbert Hubbard.*

HIGH-SPEED STEEL FOR MILLING CUTTERS.

A great many opinions have been expressed in the technical press regarding the value of nigh-speed steels for milling cutters. An article by Mr. Robert Grimshaw appeared in February, 1907, MACHINERY, in which were given the opinions of several German firms, all of whom pointed out that high-speed steel was not very efficient for milling cutters, because the cutting speed cannot be increased in the same proportion as on lathe tools. The difference in the results of milling and turning is accounted for by the fact that high-speed steel must be heated to a certain degree by the cutting operation in order to most effectively perform its work; and continuous heating of the milling cutter teeth is impossible, because they are in contact with the work for only a part of each revolution, and are cooled off in the air during the interval.

While this reasoning is undoubtedly correct, we understand that both here and in England a number of the leading manufacturers, who are users of milling cutters, find that although the cutting speed can be only slightly increased, so that the saving in time does not in itself outweigh the increased expense of material for cutters of high-speed steel, such cutters retain their cutting edges much longer than those made of ordinary tool steel; and this fact, when considering the question of economy, is nearly as important as that of high cutting speed.

In large shops, where several hundred milling cutters are in constant use, their grinding is a very important item in the expense account, and as high-speed steel cutters have to be ground less frequently, that is a distinct saving. The labor cost in the making of milling cutters is considerable, in many cases so great that the cost of material is small in comparison; and the greater the labor cost the more important it is to use material which adds to the cutter's life. The greater cost of high-speed steel becomes a heavy item in tools where the labor cost of making the tool is comparatively small; but in the case of a formed milling cutter, where the labor cost is large, the difference in the total cost between ordinary carbon steel and high-speed steel becomes insignificant.

* * *

THE GROWING RESPONSIBILITY OF WORKMEN.

Those who read the editorial on "The Growing Inefficiency of Workmen" in the December MACHINERY, will understand that we are not satisfied with the attitude of labor, particularly in the larger centers of population. We wish it were possible to find words to set forth the responsibilities and possibilities which are presented to the men in this country who make their living by the work of their hands. One often gets the impression, after listening to speeches in meetings of manufacturers' associations, industrial educational societies, etc., that it is the duty of the employer and educator to lead the American workman in the way he must go, if certain "national perils" are to be avoided.

Despite the folly often displayed by individual and organized labor, we believe that the paternal position thus taken by its "superiors" is fundamentally and absolutely false. We believe that from the workingman is coming in the present, and is to come in the future, the enthusiasm and intelligence which are to solve some of the difficulties which now seem so thickly to beset our path. He may listen to the employer and the educator, but he must think and decide for himself. Clear and honest thought devoted to the problems with which he has to deal, will convince the workman that the attitude taken by many of his fellows is wrong. As a beginning, how would it do to meditate on the matter of the truth or falsity of the following propositions:

Inefficiency and loafing—in other words, restriction of output—will not help the workman as an individual or as a class; the whole effect is injurious.

Improved machinery and processes work no harm to labor as a class, though they may temporarily injure individuals. Labor has profited from their producing power in the past, and should profit therefrom even more in the future.

These propositions touch but one side of the problem, and the employers' side at that—to judge from surface appearances. But they do not trespass on debatable ground, questionable as they may appear. A clear understanding of them is essential to an intelligent search for the still unknown, or at least unapplied, solution of the problem of the proper distribution of wealth.

* * *

FINE FINISH ON MACHINERY.

There is a growing tendency to leave off all ornamental finish on manufactured machinery. The reaction from the absurd practices of two generations ago seems to gain momentum, and perhaps it is time to call a halt before it goes too far. To illustrate, take past and present locomotive practice. In the '50's and '60's many passenger locomotives were marvels of polished brass, walnut cabinet work, bright paint and fancy striping. It gradually dawned upon railway men that though high finish meant no greater tractive power or higher speed, it did mean higher first cost and continued expense to keep it in good order, and then came the change to the other extreme. But, while the change to the present style of severely plain finish has the merit of lessened first cost and economy of up-keep, it is not without certain disadvantages. Human nature is unchanging in its love for the bright and shining; it is a trait common to all. We admire the beautiful, and the beautiful attracts and holds attention when the plain receives scant respect. The romance of the locomotive has largely departed with the coming of the severely plain styles, and with it has gone the love of the engineer for his engine. The practical is not everything, and it is quite possible that the large economy supposed to result from plain finish is more imaginary than real.

On machine tools considerable ornamental effect is possible in the finish of working surfaces. Most machine builders believe that all flat working surfaces, such as cross-rails, planer uprights, V-ways, etc., should be carefully planed, and afterwards scraped with hand tools, to surface-plates, leaving the surfaces ornamented in approved fancy designs. Now the iconoclasts argue that all this hand work is waste effort. They aver that hand scraping does not improve the accuracy of the flat surfaces but that it rather has the contrary effect, and they would have all flat working surfaces left in the condition produced by the planer. We are not prepared to accept the proposed reform yet, and there are many others of like mind.

In the first place, we believe that intelligent and careful scraping does improve the accuracy of most planed work. It doubtless is possible to produce planed surfaces that cannot be improved in accuracy by scraping, but that is not the general condition of planer work "by a long shot." In the second place, scraping changes the nature of the surface and materially improves its wearing quality. Scraping both smooths and condenses the surfaces, and a scraped surface is not so likely to scratch and cut as an unscraped surface. The unscraped surface has a "fur" of minute iron particles detached, but still clinging to the solid iron underneath. The scraper cleans this dust off, leaving a clean, hard surface ready for immediate use. In the third place, the effect of the beautiful finish on the buyer and user should be considered. We would not do away with all attractiveness, and a handsome machine tool is quite as desirable as a handsome suit of clothes. We all might wear burlap, but the resulting economy would be largely imaginary. The average man would lose more in efficiency and self-respect than he could gain by the saving in cost. In short, the utilitarian is not all of life. We must have ideals, and love for ideals is a sentiment of practical value in business as well as in art.

* * *

The value of a developed water-power is stated by Charles T. Main, mill engineer and architect, of Boston, to be as follows: "If the power can be run cheaper than steam, the value is that of the power, plus the cost of plant, less depreciation. If it cannot be run as cheaply as steam, considering its cost, etc., the value of the power itself is nothing, but the value of the plant is such a sum as could be paid for it new, which would bring the total cost of running down to the cost of steam power, less depreciation. That is, it is worth just what can be gotten out of the plant, and no more."

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

An unusual power contract has been made by the city of New York with the New York Edison Co., for supplying power for the operation of electric pumps for the new emergency high-pressure fire mains. A penalty of $500 per minute is imposed for the failure of the electric power supply within three minutes after a fire alarm.

In the December, 1907, issue of MACHINERY, we mentioned that the German Society of Engineers had discontinued the work on its *Technolexion*, on account of the high cost. It is stated in the *Times Engineering Supplement* that the society has appealed to the Prussian Government for assistance in finishing the work, and it will depend upon the decision of the Minister of Education whether the work will proceed or not.

At a meeting of the Institution of Mechanical Engineers, of Great Britain, one of the speakers mentioned that the manager of an automobile factory had stated to him that by using distilled water as a cooling medium and cutting lubricant, in place of ordinary water, he had been able to increase the life of the milling cutters, used in the factory, from five to ten times. Condensed steam from the steam engine would serve the same purpose as distilled water.

The production of denatured alcohol for the first six months of 1907, under the new law covering its manufacture, amounted to 1,774,272 gallons. The supplemental new alcohol law will, it is estimated, lead to a production of 4,000,000 gallons for the calendar year. The operation of the law has already reduced the cost of wood alcohol from prices varying between 60 and 75 cents to 30 cents a gallon, a fact which amply indicates that a fairly efficient monopoly has been established in the wood alcohol business.

Vice-Consul-General Paul H. Cram, of Marseilles, France, in a report to the Department of Commerce and Labor, calls the attention of American manufacturers to the fact that it is of very little use to distribute catalogues, printed in the English language, in France, and also to the fact that circular matter or letters should state dimensions and weights in the metric system, and prices of goods, delivered in France. Letters to France should also preferably be written in French.

New records in wireless telegraphy are constantly being established. A despatch from Berlin states that the Wireless Spark Telegraph Co. has transmitted a message between its station near Berlin and the Hamburg-American liner, *Cape Blanco*, off Teneriffe, a distance of 2,290 miles. Wireless communication has been established between the coast of Morocco and Paris, France, the Eiffel tower station communicating with war ships on the coast of Northern Africa, a distance of nearly 1,200 miles.

Experiments have been carried on for several years at the Oerlikon Machine Works, in Switzerland, with electrical trains for the purpose of ascertaining the best methods of electrically operating main line railroads with heavy traffic. The experiments are now closed, and, according to the *Railroad Gazette*, the system adopted is single-phase alternating current of 15,000 volts, with 15 periods per second, using overhead conductors. The experiments are said to have determined that there is no danger in employing high voltage, *provided proper precautions are taken*. The question is: "What are they?"

In the discussion of one of the papers presented before the December meeting of the American Society of Mechanical Engineers, it was stated that the limit of superheating desirable for Corliss engines is 500 degrees F. If the steam is used at a higher temperature, the valves warp and bind, due to their unsymmetrical form, and in some cases, cylinders have been known to change their shape sufficiently to cause difficulties. In engines fitted with ordinary slide valves, no difficulty is experienced, except with lubrication, but this has, in some cases, been overcome by direct oil connections to the valve seats.

It is stated that, at the present time, there is a large demand for machinery in China. The imports of machinery are constantly increasing, being, in 1906, nearly three times as high as the average for the previous five years. Great Britain supplies the greatest amount of the demand, Germany, the United States, and Belgium coming next, in order. Industrial undertakings are, at the present time, favored to a great extent by the Chinese, and there is undoubtedly an opportunity for firms who are able to supply considerable quantities of the machinery demanded.

A short description is given in the *Practical Engineer* of a number of "rail-less tramways" now in operation in different parts of Germany, for the conveyance of both passengers and goods. The cars consist of dirigible vehicles, propelled by electric motors, which receive their current from an overhead conductor, supported on trolley poles. The cars have sufficient freedom of movement to enable them to turn aside about 12 feet in either direction from their wires. When two cars, traveling in opposite directions, meet, the contact rods of one are removed from the wires, and replaced when the other car has passed by. The first tramway on this system was constructed in Saxony, in 1901.

It is stated in *The Times* (London) that the Danish Government is considering a project to construct a railway tunnel under the Great Belt. The total length of this tunnel would be about 17 miles, of which 12 miles would be under the sea. The estimate of the cost is put at slightly more than $7,000,000. At the present time, there is a train ferry service across the Belt, but it is often handicapped by bad weather, and it is calculated that the tunnel service would be profitable, even if the cost were considerably more than the estimate given. Test borings have shown that the condition of the materials in which the tunneling work would have to be carried out is favorable for the work.

It is mentioned in the *Mechanical World* that an English firm has lately been experimenting with the object of producing a file which will do more work and last longer than files made from ordinary tool steel. The outcome of these experiments is a new special chrome-steel file. These files have recently been tested at Sheffield, with excellent results. The total number of strokes made with the file tested was 270,000, the strokes per minute being 51, and the number of hours 88¼. The amount of filings removed during this time was 10½ pounds. The makers, W. Atkins & Co., Ltd., Sheffield, England, claim that this is far in excess of any result known at the present time, and that it represents a marked advance in the cutting power and ability of files.

The German navy has ordered one of its ships to be fitted with an electric propulsion system of the Siemens-Schuchardt type. According to this system, the power generated in the engines—in this case steam turbines—is converted into electric energy, and part of it is stored in accumulators and is utilized as occasion may require. It is not stated what advantages are expected to be derived by this system, excepting, possibly, greater flexibility of the power. The steam turbine alone, of course, drives the propellers at too high speed for economical working, whereas if the steam turbine is used at a high speed of revolution, and corresponding high efficiency, and electric power transmission, with low rotating speed of the propellers, is employed, greater economy is obtained. The propellers can be controlled directly from the bridge by this method, which, of course, would be a decided advantage.

As a result of a two years' trial of a four-cylinder, balanced, simple locomotive, on the London and South Western Railway of England, says the *Railway and Engineering Review*, a number of ten-wheel locomotives of this type have been designed and built by the railway, and put into service as a standard for heavy passenger service. The boilers of these locomotives have a tube heating surface of 2,210 square feet, a fire-box heating surface of 160 square feet, and 357 square feet of additional fire-box heating surface, secured from cross water-tubes. The grate area is 31.5 square feet. No injectors are used, these being replaced by two duplex feed-pumps, and the feed-water is heated by the exhaust steam from the pumps. All the cylinders are 16½ x 26 inches, the exterior being coupled to the middle drivers, and the interior to the forward drivers. The exterior valve motion is Walschaerts' and the interior, Stephenson's, both handled together by a steam-hydraulic device. All the cylinders exhaust through one pipe. The drivers are 72 inches in diameter, and the engines weigh 52 tons on the drivers, and 75 tons complete.

The passage of the free alcohol bill by Congress last year did not carry with it such enormous immediate changes in its use in the industries as was predicted, nor did the price of denatured alcohol fall to anything like the figures intimated. There are, however, strong indications that alcohol finally will become cheap enough to enter into active competition with gasoline and kerosene for a variety of power purposes. It has been shown by a congressional committee investigating the matter that the total cost of producing a gallon of 90 per cent alcohol at a large distillery in Peoria, Ill., is 18.4 cents. This, however, was when producing alcohol directly from corn. A far cheaper price may be reached by producing alcohol from potatoes, or even from the stalks of corn and corn cobs. In Cuba alcohol is now made from a cheap grade of molasses, which ordinarily is a waste product, at a cost of 10 cents a gallon, and there is no good reason why we may not ultimately expect the same low level of price to be reached in the United States. If the price were right, alcohol would, for many reasons, be far preferable to any of the common liquid fuels for power purposes.

In an article in the *L'Electricien*, a system of winding magnet coils, using bare wire, is described. The reason for the possibility of using bare wire in winding is that when two adjacent turns of the wire come in contact, they only make a line contact, and the resistance of this contact will be so great compared with the resistance of one turn of wire, that the current will flow through the wire rather than across the contact. If then the coil consists of but one single layer of wire, it is not necessary to insulate this wire, as the resistance of the contact will be sufficient to prevent short circuit. Of course, this does not apply to the second layer of wire, since the latter will come in contact with the layer below, and the resistance of the contact will be small compared with the total resistance of the intervening turns of wire. Consecutive layers, of course, have to be insulated from one another. The system is evidently limited by the diameter of the coil of the wire. If the diameter of the coil is large, and the wire is small, the current may pass across from turn to turn easier than by passing around the coil. Therefore the system is suitable for large coils only in cases when these are wound with fairly large wire. It is claimed that magnet coils wound in this way have proved satisfactory.

The automobile situation abroad seems, in some respects, not to be any more promising than that in the United States. The stocks of some of the French automobile companies have declined heavily, and although the year just closed has been one of greater sales and greater activity than in any of the previous years in the automobile industry, the future is not promising. One German automobile firm has issued a statement, in which it is claimed that a great deal too much has been spent by automobile manufacturers on exhibitions of all kinds, and that it would remove a great burden if the manufacturers would free themselves from excessive demands made upon them in this direction. The German automobile manufacturers at their annual meeting, voted not to take part in any German automobile show before September 1, 1909. This tendency undoubtedly is one which must be considered as indicating a new and healthy development of the automobile trade. The automobile shows have been largely devoted to exhibiting luxurious cars, for pleasure purposes, the commercial vehicles having been almost totally neglected. There are strong indications in Europe, as well as in the United States, that this condition will cease, and the tendency toward that firmer basis on which the industry will be placed when attention is given to vehicles that will be actually useful, is the most hopeful sign of the present time.

Should aerial flight ever become an accomplished fact so far as humanity in general is concerned, the exhibit of Mr. Henry Farman in Paris, January 13, will become of considerable historical interest. Mr. Farman sailed nearly one mile in a circle with an aeroplane flying machine heavier than air, and won the Deutsch-Archdeacon prize of $10,000. The flight was made at a height of 25 feet from the ground, and the speed averaged 34 miles per hour. The machine in plan is somewhat like that of a bird, the two wings being duplicated by two aeroplanes, one above the other on each side, with a third double aeroplane trailing behind to form the tail. The propulsion is effected by a propeller driven by a 50 H.P. gasoline engine of extraordinary power in proportion to its weight, which is approximately only 175 pounds. To enable the machine to rise from the ground, it is necessary that it be mounted on wheels so as to gain sufficient speed to balance its weight on the air before rising from the earth. These wheels are of very light construction, similar to those used on bicycles. The successful trial demonstrated that it is possible to build machines heavier than air which can raise themselves from the earth and sail in any direction, under favorable atmospheric conditions. For brief review of recent dirigible balloon exploits, see MACHINERY, January, 1908, page 281, Engineering edition.

The results obtained from some interesting experiments undertaken to ascertain the bursting strength of malleable iron pipe fittings, were published in *Power* some time ago. These experiments were undertaken by the Pittsburg Valve and Fittings Co., and the tests were made on 4-inch standard threaded malleable iron tees, both black and galvanized. The metal of all the fittings was ¼ inch thick on the body portion. It was found that the average bursting pressure for the black fittings was 2,900 pounds per square inch, and for the galvanized fitting, 2,833 pounds per square inch. The working pressure recommended by the manufacturers for these fittings is 150 pounds, giving thus a factor of safety of about 19. One of the interesting facts proved by these experiments is that the galvanized fittings can stand practically the same pressures as the black, which is contrary to the expressed belief of many users of malleable fittings, who have been very positive in their statements that galvanizing greatly weakened the strength of the pipe, because the dipping of the fitting in a bath of molten zinc, and then suddenly cooling it by immersing in cold water, would have a tendency to bring the castings back to the unannealed state, making them hard and brittle. That this theory is not correct is conclusively shown by these tests. As compared with experiments undertaken with cast iron tees, the strength of the malleable fittings is more than 50 per cent greater than that of cast iron fittings. In most cases the malleable fittings developed leakage through minute "pin holes" at pressures ranging from 1,000 to 2,500 pounds. In no instance were these pin holes visible below a pressure of 1,000 pounds with the black fittings, or below 2,000 pounds with the galvanized fittings, while two of the galvanized fittings sustained a pressure of 2,500 pounds before pin holes developed. It is therefore evident that galvanizing is very effective in closing small imperfections or pin holes in the malleable iron.

ELECTRIFICATION OF THE SWEDISH STATE RAILWAYS.

More detailed information regarding the electrification of the Swedish State Railways has now been published. As will be remembered, we have several times referred to the plans for the electrification of the Swedish State Railways, which

proposition has been given thorough consideration by the Swedish government, particularly because of the abundance of water power available in the country, and because of the fact that coal must be imported at high cost. For some time past the government railway administration has carried on various experiments with electric power on a part of the State Railways, outside of Stockholm, and the estimates for the cost of power of installations necessary have been founded on the results of these experiments. The length of the railways which would ultimately be electrified is about 1,300 miles, the total length of track, including double track and sidings, being somewhat more than 1,800 miles. Five water falls of great capacity, located at various parts of the country, will give the required power. Power transmissions will conduct electric current of 50,000 volts, which will be transformed to 15,000-volt current in the contact conductors. The transformers will be located about 30 miles apart. The total cost for conductors and transformers is estimated to be nearly $10,000,000, and for the power stations, about $6,500,000, to which would be added $400,000 for special buildings required. The estimates show that at the present time, the saving of electrification over steam traction would amount to $120,000 a year, but when the traffic increased about 60 per cent, as it is estimated that the traffic will by 1920, the saving would amount to about $400,000 a year. The estimates have been

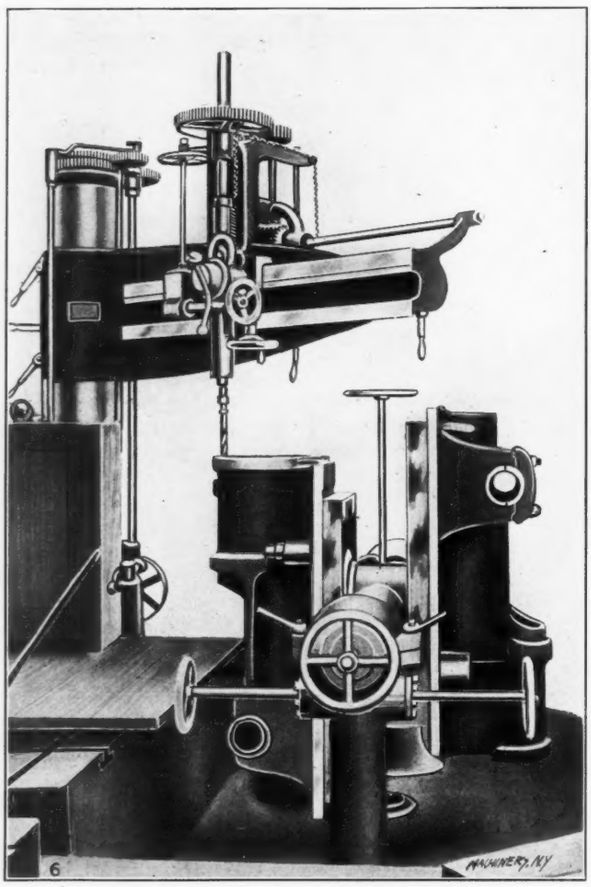


Fig. 1. Universal Table for Machine Tools.

carried out carefully into details, and it is believed that this is the most thorough scheme for the electrification of railways that has ever been worked out anywhere. A complete official report regarding all the experiments which have been carried out by the Swedish Government Railways, and the results obtained, is to be expected in the near future.

That these plans are not merely to be made on paper, but are intended to be actually carried out, is indicated by the fact that the Swedish Government, at the present time, is building its first large power station which ultimately will be capable of developing 100,000 horse-power, and has possibilities for being increased to 180,000 horse-power through the purchase of some additional water rights. This power station will not be completed to this enormous extent all at once, but, at the present time, four generators, to be driven by water turbines, have been ordered from the General Swedish Electric Co., in Västeras, Sweden. These generators will be the largest that have so far been made in Europe. They will be made of the horizontal type, and will have an outside diameter of 27 feet. Each will generate 10,000 horse-power, normally, the maximum load being 12,500 horse-power.

UNIVERSAL TABLE FOR MACHINE TOOLS.

Zeitschrift des Vereines deutscher Ingenieure.

The accompanying half-tones, Figs. 1 and 2, and the line cut Fig. 3, show the design and application of a universal table, the principles of which may be applied to many different classes of machine tools. It is primarily intended for

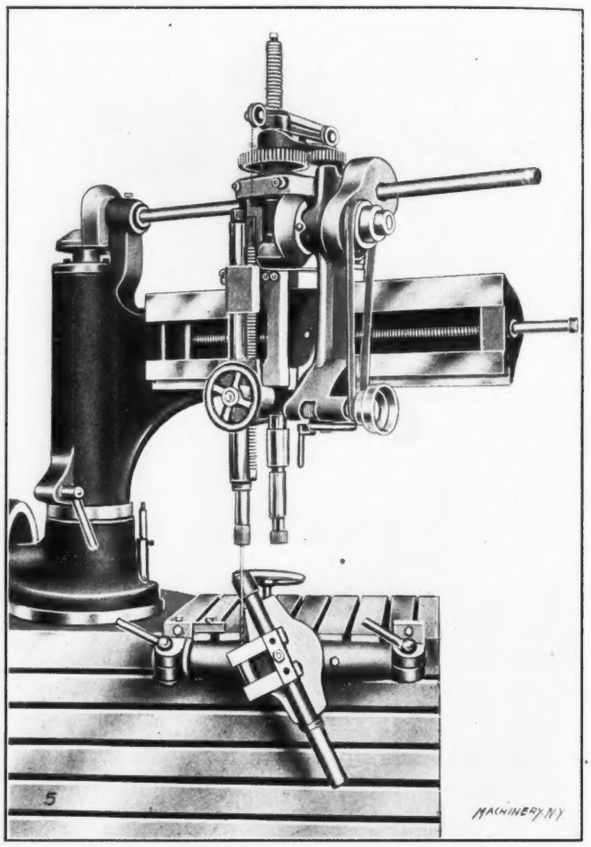


Fig. 2. Type of Universal Table used for Small Work.

pieces of work which have to be held in several different positions in drilling machines, or in special milling machines, permitting, as shown in the cut, the turning of the piece being worked upon to almost any position. The usefulness of the device in the radial drill press is most apparent from Fig. 1. The device may be mounted in different ways. In Fig. 3, for instance, it is mounted on two brackets, which are bolted to the side of the removable square table usually furnished with radial drill presses. These two brackets are provided with T-slots to which the device is clamped. This permits the device to be moved in and out along the ways on the brackets.

The device itself consists of a rotating arbor having trunnions mounted in bearings immediately over the brackets. By means of a hand-wheel, and a worm and worm-gear connection, the device can be turned to any position around the axis of the arbor. The table to which the work is clamped, is mounted at the center of this arbor, and can be swung around its own axis. The combination of this swivelling table and the rotating arbor make, of course, a perfectly universal device. The table, as well as the rotating arbor, is provided with suitable means for clamping, as will be seen in Fig. 3. There is one table provided for each side of the arbor, thus permitting work to be clamped on both sides. The half-tone, Fig. 1, shows the usefulness of this arrangement. The design of the device, as shown in Fig. 1, is not

exactly the same as that shown in the line cut, Fig. 3, but the principles applied are exactly the same. In the half-tone, however, the tables are square, and are also capable of a longitudinal movement. In the cuts shown, two gas engine cylinders, cast integrally with their frames, are bolted to the tables. The half-tone, Fig. 2, shows the same kind of a device, but of the type used for small work. In this case, the whole device is clamped to the side of the drill press table, and a case of angular drilling is shown. We understand that this device is, at the present time, used with great success in the works of Gasmotorenfabrik Deutz, of Köln-Deutz, Germany.

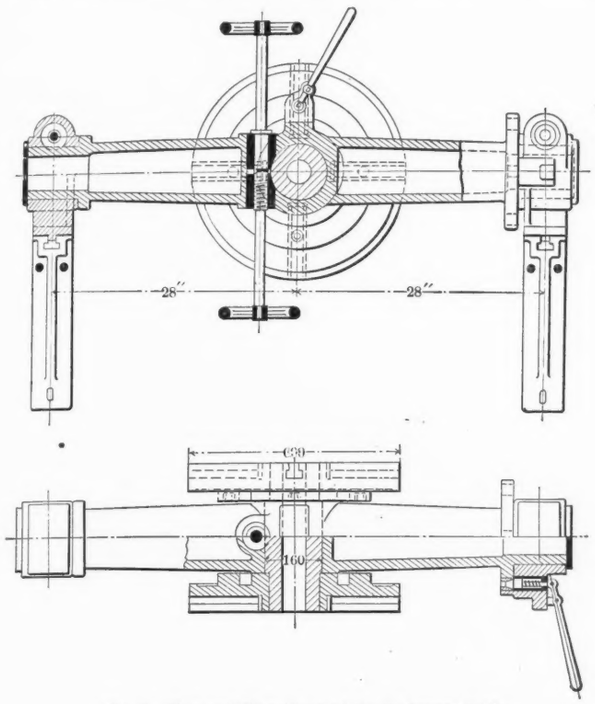


Fig. 3. Plan and Elevations of the Universal Table.

NOTES ON THE MANUFACTURE AND UP-KEEP OF MILLING CUTTERS.

H. T. Ashton, before the *British Institution of Mechanical Engineers.*

Although the system of manufacture of milling cutters, detailed below, is suitable for general application, it has been developed more particularly to meet the difficulties of extending the use of high-speed steel to milling cutters of complicated shape. It is believed that these difficulties have been commonly met with, and that, owing to them, the general introduction of high-speed steels of the Taylor-White class has, so far, generally proved of less value for milling cutters than for any other form of cutting tool used in the shop.

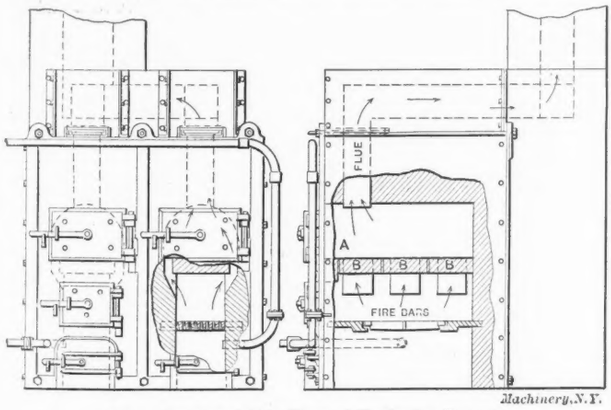
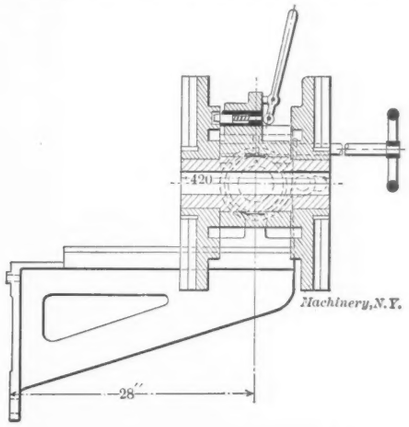


Fig. 1. Front and Side View of Hardening Furnace.

Perhaps the advantages to be obtained by the use of high-speed steel for such cutters are also not so obvious as they are for the heavy lathe or planer tools, where the almost red-hot chips, that they can be made to produce, appeal to the least observant onlooker. When, however, it is considered that this class of steel not only has the property of keeping a cutting edge for a reasonable time, when taking very heavy cuts at a previously unattainable speed, but also keeps its cutting edge when used with a moderate cut and speed for a far longer period than was previously obtainable, its advantages, if applicable to complicated milling cutters, are clearly just as great as for the simpler tools taking the heavy cuts.



For, although the nature of the work upon which the cut is taken and the finish required from the cut may not allow, in the case of the milling cutter, any great increase of speed or feed by the use of high-speed steel, and consequently little direct saving upon the time occupied in doing the work, as in the cases of the other classes of tools, yet an equally important saving is effected in the cost of supply of the tools themselves. The milling cutter is the most expensive of all the tools used in cutting metals. In the simplest milling cutter, the cost of workmanship so largely exceeds the cost of material that a moderate increase of life obtained by improvemen's in the raw material far outweighs a considerable increase in its original cost, provided that there is sufficient work in sight for the cutter to insure its being fully employed for its maximum possible life. Perhaps it is this ruling condition which has led to somewhat less attention being paid to the application of these steels to milling cutters in general machine shop practice than to other cutting tools. For in ordinary shops, with the exception of a few simple cutters generally useful for roughing out or for finishing simple profiles likely to recur, it has perhaps generally been more economical to make the cutters from ordinary qualities of tool steel, or even in some cases from specially case-hardened mild steel; hence the preparation of an elaborate milling cutter from high-speed steel has not received quite the same general attention as the preparation of other cutting tools of maximum endurance.

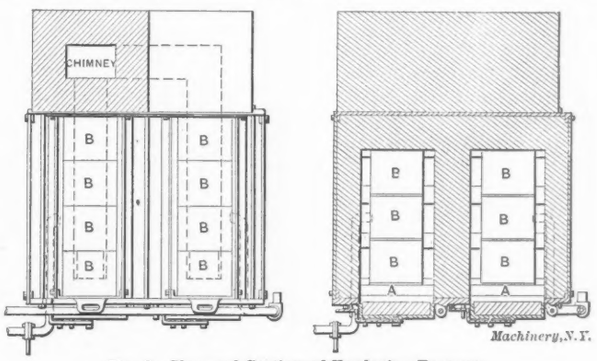


Fig. 2. Plan and Section of Hardening Furnace.

The case, however, is different in a number of shops where the interchangeable parts of many classes of apparatus and fittings depend very largely upon the use of formed milling cutters, and where the accuracy of the work so produced is directly dependent upon the accuracy with which the form of the cutter can be maintained for a prolonged period. It is desirable also that the cutters should have as long a life as possible in actual service, in order to minimize the first cost

and up-keep, and also to keep the output of the machines as continuous as possible, by reason of freedom from delays in changing the cutters. These points depend chiefly upon:

1. The quality of steel from which they are made.
2. The method of hardening adopted.
3. The care and accuracy with which the new cutters are made.
4. The facility and correctness with which the cutters can be ground when they have become dull or lost their accuracy.

The Steel Used.

There is, of course, nothing to compare with the recently developed high-speed steels as a material for cutters which are required to work at a high cutting speed and have the maximum possible life; and no difficulty is now experienced in obtaining work with a sufficiently satisfactory finish, provided care is exercised in the grinding and finish of the cutters, in the manner which will be described, and also if the cutting speeds and feeds are suitably arranged. Any of the best-known makes of this class of steel can be used in conjunction with the system to be described.

The steel is annealed by packing in spent powdered charcoal and steel turnings in cast iron pans with covers which are luted down. These are placed in the annealing furnace the first thing in the morning, and are gradually heated up to 1,300 or 1,400 degrees F.; this heat is usually reached by 1 o'clock and is maintained until about 5 o'clock, when the dampers are closed and the furnace is allowed to cool gradually for forty-eight hours. It is found that some makes of high-speed steel are satisfactorily annealed by the makers, but it is not the universal practice. Annealing in this manner is found to give thoroughly satisfactory results.

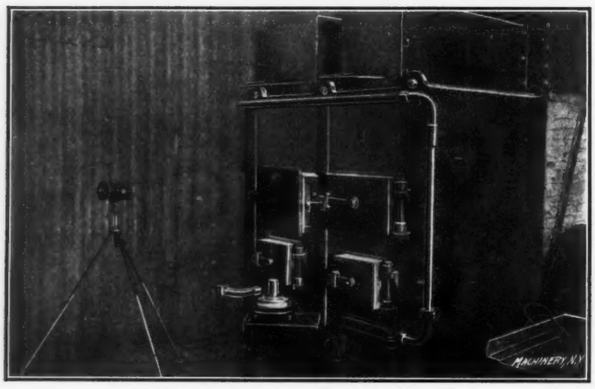


Fig. 3. General View of Hardening Furnace.

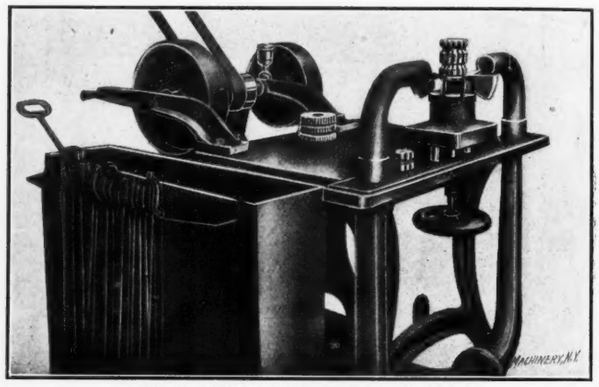


Fig. 4. Method of Hardening by Air Blast.

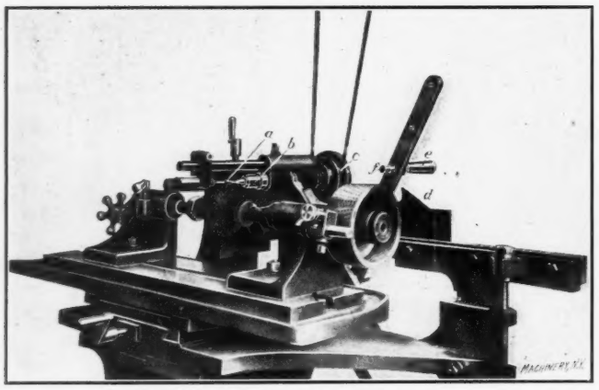


Fig. 5. Milling Teeth of Formed Cutters.

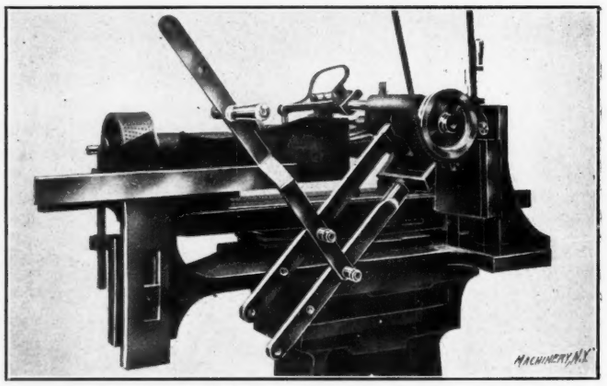


Fig. 6. Front View of Machine for Milling Teeth of Formed Cutters.

Method of Hardening.

The furnace used for hardening cutters is shown in Figs. 1, 2, and 3, and it has been found specially adapted for obtaining a soaking heat, together with the high temperature necessary in treating this class of steel, and freedom from oxidation. The furnace is coke fired, and has a forced draft, and temperatures up to 2,300 degrees F. can be obtained.

In using the furnace, the cutters are packed closely in powdered charcoal in sheet steel boxes about 6 inches by 6 inches by 3 inches. These boxes take from 2¾ to 3 hours to reach the necessary hardening temperature, the time taken varying with the weight of metal to be heated. The hardening temperature varies somewhat according to the class of steel being used, but may be said to be between 2,000 degrees F. and 2,100 degrees F. The exact temperature necessary for satisfactorily hardening any particular class of steel is previously determined in the laboratory by exact experiments, and the temperatures obtained in the furnace are checked by means of a Fery radiation pyrometer—also shown in Fig. 3. This pyrometer is itself tested against a standardized Callendar pyrometer, and has so far given extremely reliable results.

The cutters, when sufficiently heated, are quickly removed from the charcoal in which they have been packed, and are at once placed upon the hardening table shown in Fig. 4. This table is of a type frequently used in workshops for heating tools by gas, but when used for hardening cutters, air only is supplied through the two nozzles. These can be moved, as required, about vertical pivots, so as to cause the air blast to impinge upon the periphery of the cutters at any required points and simultaneously upon the vanes of the spindle upon which the cutter is placed, causing the whole arrangement to rotate and thus equalizing the cooling and hardening effect. The air delivered upon the cutter is drawn from a culvert which passes under the floor of the workshop and through which a stream of water continually flows; hence at all times of the year a supply of cold damp air of maximum cooling effect is available. The temperatures used in hardening are such that the edges of the cutters are almost fused, and although different makes of steel have been found to vary somewhat in this respect, the general statement remains true of all of them. At the same time, it is found that this fusing effect for a given heat is considerably minimized by the method of heating in closed boxes, as compared with the ordinary method of heating tools either in a muffle or directly in a gas flame, and even the scaling, which, with the latter systems, is frequently marked, is, with the method now described, so slight that the cutters can be wholly freed from scale by placing them momentarily under a revolving scratch brush.

All difficulties as regards the expansion of the hole through the cutters in hardening are met initially, leaving the bore slightly smaller than is ultimately required—on the average about 0.010 inch less than the finished diameter; the expansion

is usually about 0.003 inch to 0.005 inch, the average diameter of the mandrel being 1 inch. After hardening, the milling cutters are first chucked truly with the outside diameter in a self-centering chuck, and the internal bore is ground up truly to the finished diameter. After this, the hardened cutters are chucked upon mandrels and the teeth are finished upon the special machines to be described.

Forming Cutter Teeth.

Accuracy of form of the cutters is secured, both when being cut in the first place, and also when subsequently re-formed, by turning the blanks and milling out the teeth in the ordinary manner, and then backing them off in the machine shown in Figs. 5 to 8. In this machine, the cutter to be formed is carried on a dividing head, so that one tooth at a time can be presented to the small milling cutter *a*, Fig. 5. This is mounted upon the cutter spindle *b* driven by a pulley *c*, from which cat-gut cord runs through an overhead gear, allowing the spindle to be moved within the necessary limits. The small cutter spindle-frame forms part of a system of adjustable pantograph links, so that its movement is an exact reproduction in miniature of the movement of the tracing pin upon the former *d* fixed in front of the machine. The operator, by means of the handle *e*, moves the pin *f* lightly along the former, and consequently also moves the cutter over the tops of the teeth to a similar but smaller shape. The small cutter is enlarged in diameter toward one end, so that it cuts away the back of each tooth upon the cutter to the necessary extent. Commonly a conical backing-off cutter is used, the angle of the cone being 20 degrees, and the setting being such as to give an angle of relief of 10 degrees, that is, the axis of the cone is at right angles to the radial face of the tooth being backed off. It will be seen that this characteristic enables the machine to produce teeth of any form, upon a cutter backed off in every direction from the cutting edge, so that a clean cut can be taken with the sides as well as with the tops of the teeth.

In the case of those milling cutters in which grinding back the faces of the teeth so backed off might cause serious inaccuracy, owing to its throwing back the radial cutting edges of the teeth, the cutters are built up of annular sections which are either clutched together or clamped together upon plain faces, from which, after a particular grinding or series of grinding operations, the same amount is ground off as that by which the radial cutting edge has receded. Where the edges of the teeth are parallel or nearly parallel to the axis of the cutter, the profile is, of course, not appreciably affected by grinding back the faces of the teeth. A further means of avoiding such errors is also to be found in grinding the tops of the teeth in the manner subsequently described.

As it is found advantageous, in order to obtain a fine finish, to use helical teeth upon milling cutters, a fitting consisting of a sleeve with spiral slot—see Figs. 7 and 8—can be mounted on the same spindle as the milling cutter. A pin on a hinged arm centered above the backing-off cutter spindle is arranged to slide in the slot in this sleeve so that, as the frame carrying the copy and the cutter spindle is moved backwards and forwards along the axis of the cutter being backed off, the helical teeth are maintained in correct relation to the backing-off cutter, while at the same time they are backed off to the correct profile. Theoretically, of course, in such cases, the axis of the cutter being operated upon could be inclined to the axis of the backing-off cutter spindle at an angle equal to that of the spiral of the cutter being produced, but in actual practice it is found that this adjustment is very seldom necessary, as the cone angle of the backing-off cutter, and also the amount of material which can be removed from the cutting edge of the cutter being produced, are both, comparatively speaking, small.

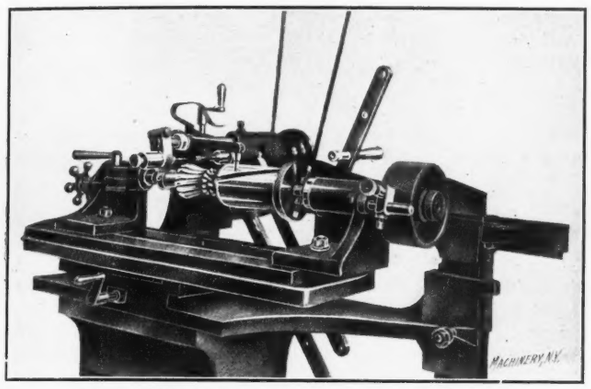


Fig. 7. Milling Spiral Teeth by means of Guiding Cam.

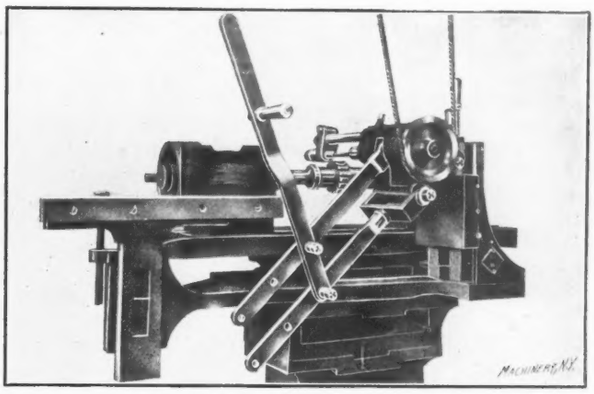


Fig. 8. Front View of Machine rigged up for Milling Spiral Teeth.

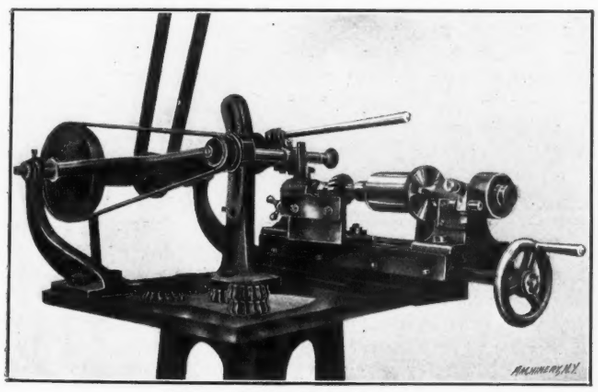


Fig. 9. Grinding Formed Cutters.

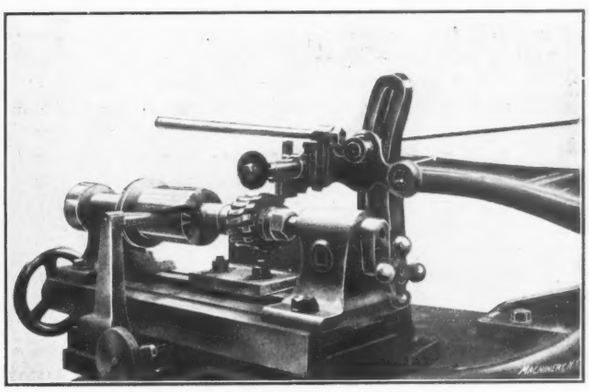


Fig. 10. Front View of Grinding Machine.

This machine has been found not only capable of backing off satisfactorily cutters of a shape which could not be backed off along the whole length of their profile in an ordinary relieving lathe in one operation, but it has been found possible to do the backing off in, approximately, one-third of the time required on a relieving lathe, while at the same time a less expensive class of labor may be employed, and the finish of the teeth is found to be better.

Grinding Cutters.

Figs. 9 and 10 show the machine used for sharpening the cutting edges of the hardened milling cutters and subsequently regrinding their faces or edges as required from time

to time. This machine has a grinding wheel mounted upon a spindle suspended on a swinging frame, and follows the work by the use of a former, the profile of which is of the same magnitude as the one to be ground. In an ordinary way, this former would not have the exact outline of the shape desired on the finished cutter, corrections having to be applied for the diameters of the tracing roller and also of the grinding wheel, the latter item being, of course, itself, variable. This difficulty is overcome by using grinding wheels of special fast-cutting artificial stone, which will perform a considerable amount of useful work before being appreciably reduced in diameter, and by making the diameter of the tracing roller equal to the diameter of the grinding wheel; there is in addition, of course, an adjustment for raising or lowering the former.

The milling cutter being ground is, as before, mounted upon a dividing head, in the case of straight cutters, or upon a dividing head provided with helical sleeve in addition, in the case of helical teeth cutters, and all the teeth are first ground along the tops to profile and afterwards in the usual manner down their faces, the grinding wheel being, of course, set over to the angle of the spiral. The cutter thus finished has edges both of the maximum keenness and also of the maximum endurance due to correctly hardened high-speed steel, as only the thin skin partially oxidized in heating before hardening is removed.

Hitherto the apparatus employed for sharpening profile cutters for milling machines in repetition work, such as is produced in small arms factories and elsewhere, has required the handling and attention of men with considerable training and skill. The provision of simple machines, such as those described, now enables an unskilled man to regrind correctly all cutters brought to him with considerable rapidity and the minimum possibility of error. By standardization of the pitches of the teeth and their angles, and by the provision of suitable templets for each of the cutters commonly required, the use of these machines has been found to result in distinct economy, both in the up-keep of cutters and also in the quality of the work turned out.

Considerable advantages result from being able to re-form accurately the contour of the teeth, in addition to grinding the face. In ordinary use, the teeth of milling cutters are damaged not only on the face, but to an even greater extent on the top, and it has frequently been found that removing, say, 0.002 inch from the top has as beneficial an effect as removing 0.006 inch from the face, and with this additional advantage that, when a tooth has been ground to its fullest extent from the face, it can be further sharpened on the top while still retaining its correct figure, until the tooth is too short through not allowing the necessary clearance; and this consideration will, in many cases, lengthen the life of a cutter by 10 per cent.

The life of some milling cutters prepared by the methods indicated above has been extraordinary; for example, a cutter working in an automatic cross milling machine and operating upon the bodies of a service rifle at an average cutting speed of 69 feet per minute, with a feed of 1¾ inch per minute and a depth of 0.08 inch, and taking a cut of an average width of 1 11/16 inch and ⅞ inch long, has produced 39,170 bodies, and is still good for about half as many more. This particular cutter has been reground across its face twenty-five times. The composition of the steel upon which it operates is 0.5 to 0.6 per cent carbon, with an ultimate tensile strength of not less than 35 tons per square inch.

ELECTROPLATING IN QUANTITIES IN DRUMS.

Deutsche Metall Industrie Zeitung

In the last few years there have been made quite a number of apparatus for electroplating small articles in quantity. In most of these, the pieces to be plated are placed in rotating drums with perforated walls. The drums are partly constructed of non-conducting materials, and the objects to be plated are held by metal strips, which are put in electric connection with the source of current, in different ways. As such apparatus are now in very extended use, a few hints as to their practical employment should not be out of place,

Almost every one who works for the first time with a drum apparatus experiences more or less trouble therewith. As a rule, the apparatus is not to blame therefor; it is the fault of the operator, who is not familiar with its working. The greatest difficulty in using a drum apparatus is when the tension is not high enough. Ten to fifteen volts are necessary in order that the currents shall flow through the electrolytes in the drum. The reason for this is the resistance which the drum makes to the passage of the current. This is just the same as when a non-conducting substance comes between the anode and the piece to be plated. The current will not flow through the solution; and if this does not take place, no metal will be deposited.

For some kinds of work a six-volt dynamo will suffice; but the results obtained therewith are, however, not especially good; also, the deposit does not take place so rapidly as with higher voltage. In such case only a small number of articles can be placed for plating in the drum. Where there are too many, the deposit takes place too slowly, and with great irregularity. With higher tension, the desired amount of metal is deposited in a short time on the articles.

Of equal importance with the current voltage is the strength of the solution. It is useless to try to electroplate with a weak solution. The resistance of the solution, in combination with that of the drum itself, prevents the passage of the current. For instance, a nickel solution of 5 to 6 degrees Beaumé, which is strong enough for ordinary electroplating, is not suitable for drum work. In the latter case, either the articles will not be covered, or only their edges will be plated. If, however, a solution of 8 to 9 degrees Beaumé, or a saturated solution, be used, the deposit will be made with success. The same is the case with brass and copper solutions. Electroplaters who get the best results with the drum apparatus, always employ strong electrolytes.

The rotation speed is of no very great importance. It is only necessary to keep the articles in motion. If the speed is too high, however, the objects have a tendency to fly to the walls of the drum and lie there, where their entire surface is not subjected to the action of the current. Special care must be taken to have all the electric connections perfectly clean and properly arranged. If this is not the case, it will be impossible to pass the necessary current through the solution; and the deposit of the metal will in such case be irregular. The same is to be noted in connection with the drum; the holes or slits therein must be kept free from salt crystals and foreign substances. It is often found that imperfect deposit is caused by stoppage of the holes through which the electrolyte and the current pass.

In plating with copper, bronze or brass, there are no conducting salts which can be added, but none are needed; it is only necessary to have the solution as strong as possible. In nickel-plating, it is recommended to use two conducting salts, as for instance ammonia, with either ammonia sulphate or common cooking salt. These salts increase the conductivity of the electrolytic solution. No definite quantity of these can be mentioned as necessary, but the electrolyte will need only a small quantity of these salts. The usual rule is to take as much as the nickel solution will dissolve.

The surfaces of the anode in a drum apparatus should be large, and so arranged that they surround the drum on all sides. In this manner the solution can work the best. A nickel solution requires constant watching. If the electrolyte is too acid, as is often the case, there must be added, to reduce this acidity, nickel carbonate. Boracic acid is used in the drum apparatus in the same way as with other nickel solutions.

In the regular drum apparatus, bars, chains, etc., cannot be plated with advantage, because, by reason of the rotation of the drum, they bend and tangle so as to make a knot that can hardly be loosened, and the regular plating of which is impossible, and they also may cause short-circuiting in the drum. For such articles special apparatus should be employed, of the so-called swinging type, which do not cause these difficulties. These latter have a half-drum of non-conducting material with a swinging motion, and a fixed anode, and permit the articles in the bath to roll from one side to the other, which prevents tangling. R. G.

THE A. C. A. AUTOMOBILE DYNAMOMETER.

The accompanying illustrations show a very interesting apparatus recently installed by the Automobile Club of America on the eighth floor of its new reinforced concrete garage and club house at 247-259 West 54th Street, New York, for testing the tractive power, speed and internal resistance of automobiles. The need of a reliable and official testing apparatus for demonstrating the power and speed of motor cars has been keenly felt. The claims of agents and builders, in many cases, have been open to suspicion, and buyers have felt with good reason that their purchases by no means fulfilled the promises made. The apparatus shown in the illustrations was designed under the direction of Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Co., Ampere, N. J., who is vice-president of the Automobile Club of America. In 1904 Dr. Wheeler was requested to design and build a testing apparatus which would meet the practical requirements of automobile testing and at the same time

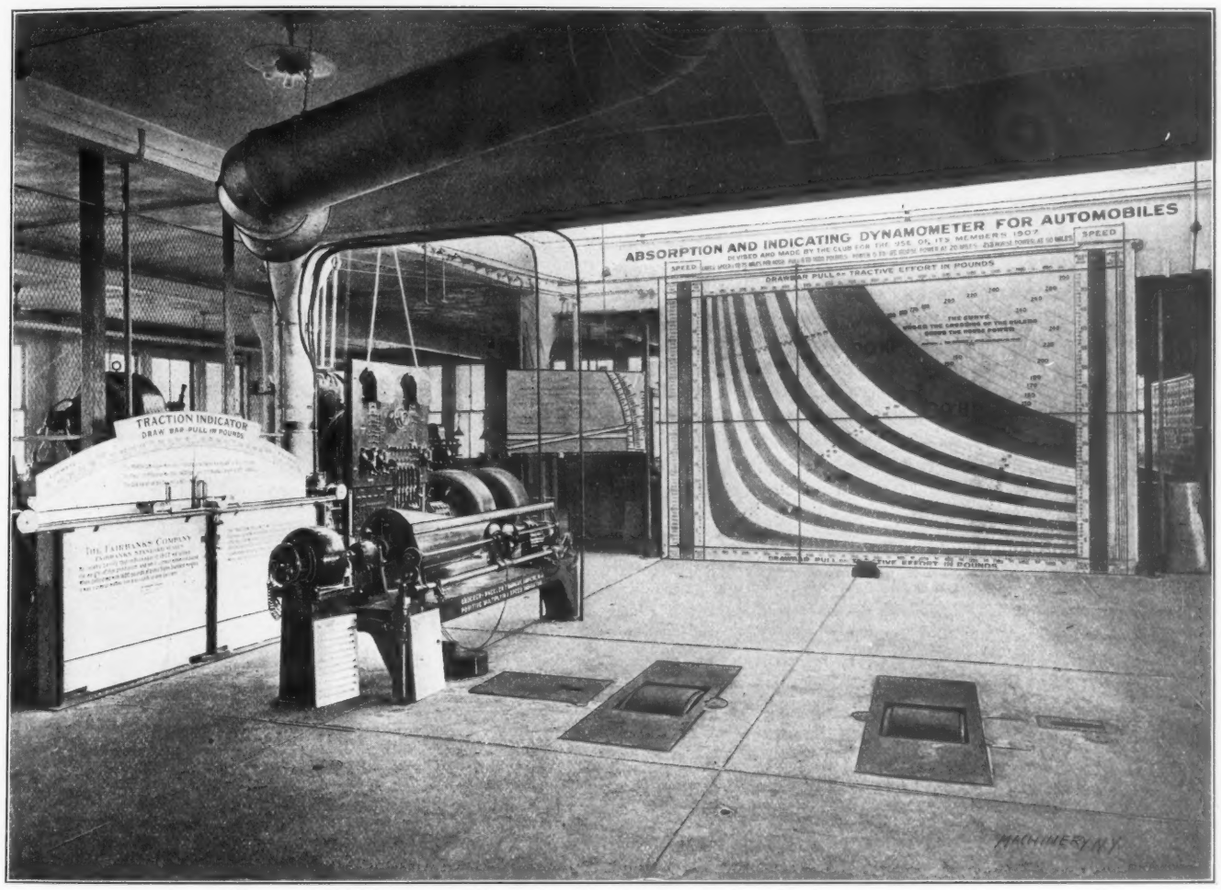


Fig. 1. General Appearance of the Testing Floor of the Automobile Club of America, New York.

be so designed as to avoid criticism of the captious-minded. The requirements were scientific accuracy, convenience of use and the indication of the results in terms that the ordinary layman could understand. For the past four years the engineers of the Crocker-Wheeler Co. have been working on the problem, and the result apparently leaves little to be desired.

The general appearance of the testing floor is indicated in Fig. 1. The automobile is driven in facing the large horse-power chart shown on the wall, and to such position that the rear wheels will stand on the rollers or drums sunk in the floor. It is then hitched to stops fastened in the floor both front and back, the stop in front showing directly underneath the brake horse-power chart. The construction of the testing apparatus is similar in principle to that employed in locomotive testing machines such as are in existence at Columbia University, New York, and in the Pennsylvania R. R. testing plant at Altoona, Pa., so far as the absorption of power is concerned, but in addition it has apparatus of unique design never before applied to such use.

The rotation of the rear or driving wheels of the automobiles drives the drums, which are mounted on a shaft below the floor, as shown in Fig. 2. Upon this shaft are mounted an Alden absorption brake and a pendulum having a weight of 1,600 pounds. The traction of the wheels transmitted through the absorption brake rotates the weight-arm to an angle dependent upon the force exerted. This is indicated diagrammatically in Fig. 3. In line with the same shaft is mounted a motor which can be connected to the traction shaft by a clutch. The object of the motor is to determine the power consumed by internal friction of the engine and driving apparatus, the consumption being indicated in amperes and volts on the indicating electrical apparatus. Right here it may be said that the internal resistance of most automobiles is high, being about 25 per cent of the indicated horse-power. Machines have been tested wherein the resistance was much higher, being, for example 18 horse-power in the case of a supposed 50 horse-power car. The section of the shaft on which the weight-arm is mounted is fitted with two dash-pots connected by bell-crank levers, as shown at the left in Fig. 2. The object of these, of course, is to prevent violent fluctuations of the weight-arm under the influence of unsteady driving.

The results of the tests are plainly evident to the driver, being indicated by the horizontal and vertical rulers, plainly visible on the horse-power chart in Fig. 1. This chart is ruled with hyperbolic lines and these sections are alternately shaded white and green, thus making the readings at intersecting points of the rulers plain. The horizontal ruler indicates miles per hour, and the vertical ruler gives the draw-bar pull or tractive effort in pounds. The horse-power is the component of the speed, generally computed in feet per minute in engineering calculations, and the draw-bar pull in pounds, but the chart is figured to indicate the horse-power by the more convenient formula:

$$\text{H. P.} = \frac{\text{pull, in pounds} \times \text{speed, in miles per hour}}{375}$$

The capacity of the apparatus is from 1 to 75 miles per hour and from 0 to 213 horse-power at 50 miles per hour. The chart was ruled by plotting the curves with the apparatus working under known conditions, the traction pointer arc being graduated at the same time in accordance with calibrations made by the Fairbanks Scales Co.

The tractive force of the automobile being indicated by the angular displacement of the weight-arm, it becomes very desirable that it shall encounter no other resistance than that

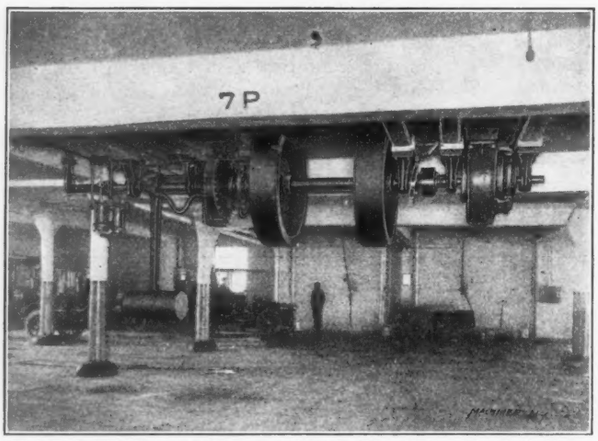


Fig. 2. Drums, Drum-shaft, Electric Motor, Alden Absorption Brake, Etc., underneath Testing Floor.

due to gravitation. If the friction of the indicating apparatus were added, it would produce a variable and, therefore, uncertain resistance that could not be accurately predicted. To overcome this the apparatus is so arranged that it provides the force to move the traction indicator (horizontal bar on the chart) entirely independent of the displacement force exerted by the automobile drivers. As the vertical pointer shown at the left of the half-tone, Fig. 1, moves along the graduated arc it makes an electrical contact on one of the small slides or carriages shown on the horizontal track, whereupon a small motor (beyond the traction chart) called "traction follower motor" winds up a thin steel wire cable causing the carriage to follow the pointer and at the same time moving the traction ruler on the large chart to the correct position. The moment it reaches this position, the electrical contact is broken, and if the motor over-travels, another contact is made which reverses it, thus keeping the carriage in constant attendance to the vertical pointer. When testing an automobile, in backing, the vertical traction pointer moves in the

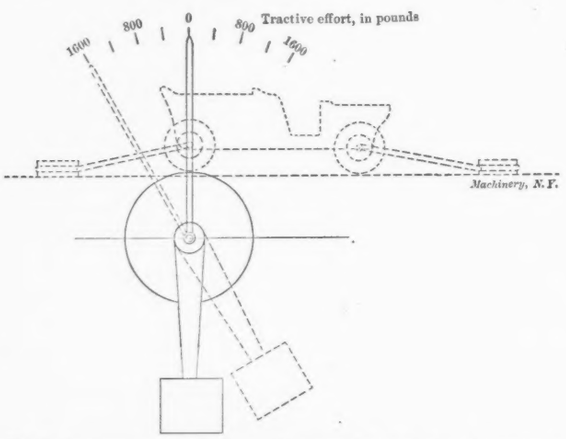


Fig. 3. Diagrammatic Elevation of Automobile on Testing Apparatus, showing Traction Indicator.

opposite direction and a twin carriage is provided which acts in the same manner in the opposite direction. To prevent injury to the apparatus because of violent fluctuations that the dash-pots cannot control, the vertical pointer is provided with a spring connection to the brake shaft which unhooks in case of a violent jerk and permits the pointer to fall behind the angular position of the weight arm and to catch up with it under the influence of a coiled spring. Thus the follower motor is given time to traverse its carriage and indicator without causing undue stress. The resistance of the drum shaft to rotation in its ball bearings is about 25 ounces, starting from rest without load of the automobile superimposed.

The same general principle as just described is employed to indicate the speed in miles per hour, but as the element of time enters, the apparatus is somewhat more complex. The machine shown in Fig. 4 is solely for this purpose, and has been ingeniously worked out. It consists of a conical drum driven by a constant-speed motor at the rate of 200 revolutions per minute. The rate of rotation is fixed by a sensitive centrifugal governor mounted in the large end of the cone, and a timing bell is provided which rings each half-minute, or at each one-hundredth revolution. Thus, a stop-watch can be used to check the timing bell and the speed of the cone. Parallel with the cone surface is mounted another shaft called the speed shaft, upon which is mounted a thin friction disk. The disk is not firmly held to the speed shaft, but, between the limits of the stops formed by electrical contacts, it is driven by the friction caused by the pressure of a small coil spring forcing it against a shoulder on the splined bushing upon which it is mounted. Thus, within the narrow limits of oscillation permitted, it tends to run at the peripheral speed of the cone shaft at the section with which it is in contact. The speed shaft is driven from the drum shaft, which is beneath the floor, by a chain, bevel gearing and a vertical shaft not very plainly shown in Fig. 1. At

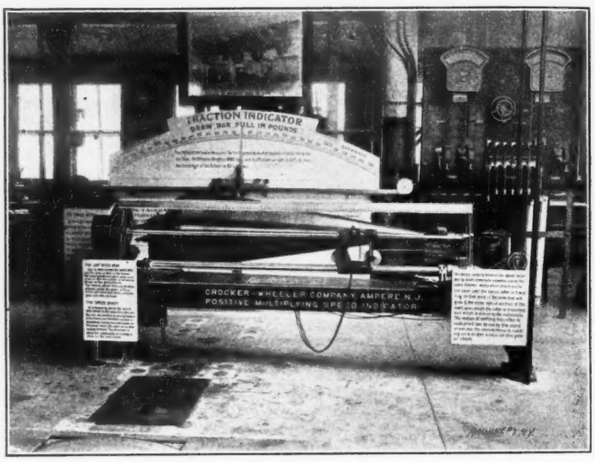


Fig. 4. Crocker-Wheeler Multiplying Speed Indicator.

the right of the machine is a small motor designated as the "speed follower motor." The function of this motor is to traverse the disk and its mounting on the speed shaft to such position on the cone that the disk peripheral speed is the same as the cone peripheral speed at the point of contact. If the disk runs either faster or slower, the difference in speed causes the disk to shift relatively to the speed shaft and make an electrical contact, front or back. These contacts actuate the motor which shifts the disk either to the right or left as is required to make its peripheral speed the same as the cone peripheral speed. The shifting of the disk actuates the vertical ruler on the horse-power chart shown in Fig. 1. Therefore, this ingenious arrangement also imposes no additional load on the dynamometer shaft; it simply follows up the indication of the speed shaft substantially as does the vertical traction ruler follow the vertical traction pointer over its graduated arc.

At the left of the horse-power chart, Fig. 1, is a grade meter indicator, the object of which is to show the angle of inclination of grade that the car would climb if there was no wind resistance, slipping or track resistance. To use the grade meter, the sliding poise is set upon its beam at the point representing the weight of the car. This change of the sliding poise changes the point of contact of the beam with a horizontal ruler (between it and the board backing) that is raised and lowered by small wire cables from the traction indicator. The grade as indicated is proportional to the tractive effort, being expressed by the formula:

$$\text{sine of grade angle} = \frac{\text{tractive effort}}{\text{weight of car}}$$

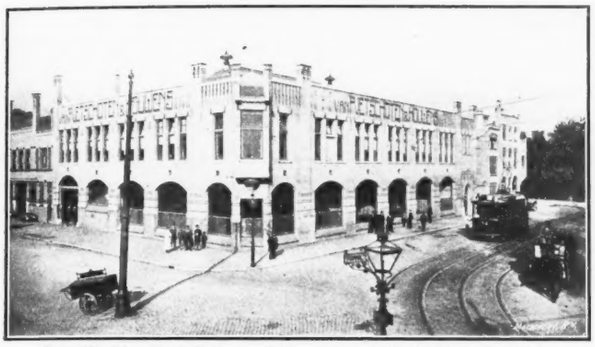
The indicator also shows the grade in per cent, the formula being:

$$\text{Grade in per cent.} = \frac{100 \times \text{pull}}{[(\text{weight})^2 - (\text{pull})^2]^{\frac{1}{2}}}$$

* * *

HANDSOME MACHINERY HOUSE IN ROTTERDAM.

The accompanying half-tone shows the handsome building recently constructed by Van Rietschoten & Houwens, Rotterdam, Holland, for a machine tool depot and showroom. The attractive appearance of the building is in decided contrast with the usual American structure built for such purposes. It was designed with much taste, and is a creditable ornament to any commercial district. It is built of hard pressed brick of light tint, the name of the firm being picked out near the top in dark-colored brick. Incidentally the half-tone shows the remarkable cleanliness of city streets in Rotterdam, this characteristic being common to Dutch cities. Holland suffered much in the depression of 1907 and money was at a high premium, consequently little business was done, and 1908 so far shows small prospects. Notwithstanding the discouraging times, the concern built these warerooms, believing that the "harder the times the stronger the push" should be. The sentiment is one well worth attention by American concerns.



New Machine Tool Depot and Showroom in Rotterdam, Holland.

* * *

Brass manufacturers are, as a rule, not very eager to use fluxes for protecting the metal, in melting, from the action of the air and the gases of the fire, because most of the fluxes used attack the crucible. The *Brass World* says, however, that there is no question about the value of the fluxes, and that glass has proved to be suitable for this purpose, and that it is used to a large extent by rolled brass manufacturers, who by this means are able to get their spelter loss considerably lower than one per cent. The reason for the excellence of glass as a flux in melting brass is that it does not become actually liquid, and therefore does not attack the crucible. It becomes pasty, and thus covers the metal, but is readily skimmed off, a difficult operation with a liquid flux. When the metal is ready to cool, the glass will be found on the top in the form of a soft "pan-cake," which may be easily skimmed off. The cheapness of glass and the fact that the crucible is not attacked, render its use attractive, and many manufacturers have been accustomed to employ it. Its good effects, however, are not generally known.

* * *

The beneficial effect of safety appliances is well exemplified by the results obtained by the constant application of means of prevention of accidents in British mines. Fifty years ago the death rate was 5 per 1,000 of the mine employes. Safety appliances, however, have gradually reduced this figure to 1.4 per 1,000 employes. While the difference between the figures fifty years ago and now may be greater in this industry than what could be effected in other less dangerous occupations, there is no doubt whatever but that nearly all of our industries could cut down their casualties to one-half, were proper appliances for safeguarding of life and limb universally used.

HEAVY SPIRAL CUTTING ON THE MILWAUKEE MILLER.

In Fig. 1 is shown a Milwaukee milling machine, built by the Kearney & Trecker Co., of Milwaukee, Wis., engaged in a milling operation on a piece of work which weighs something over 1¾ ton. This piece is the blank for a roll used for forming the tie-plate shown in Fig. 2. This tie-plate is rolled from a steel strip, and has flanges and ribs on its under side, and herring-bone corrugations on the upper surface. There is also a ledge on top for aligning the plate with the rail. All of these projections and grooves are formed by rolling. In the lower roll, of course, it is simply a matter of turning the proper shape on the surface of the roll. The upper roll is more complicated. It is shown diagrammatically in Fig. 3. The acting surfaces are composed of herring-bone projections, separated into sections by the triangular grooves which form the ledge for the flange of the rail. These grooves and projections are milled from the solid, and it was for this operation that the fixtures and attachments seen in place on the machine in Fig. 1 were made.

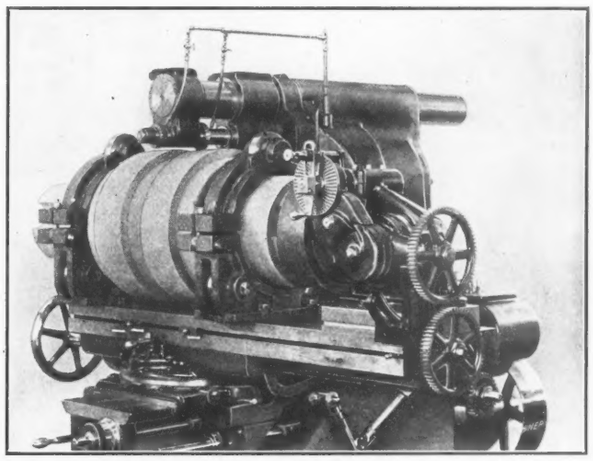


Fig. 1. Milwaukee Miller arranged for Cutting Cross-grooves in a Heavy Roll.

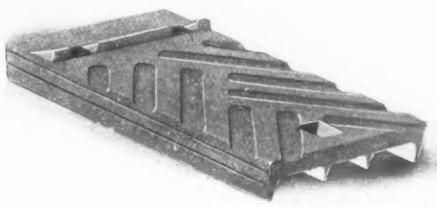


Fig. 2. The Tie-plate, which is the Product of the Roll.

It was seen that the work was so large as to exceed the vertical capacity of the machine. For this reason it is necessary to provide a supplementary cutter spindle which brings the arbor and cutter closer to the overhanging arm. This arbor is carried on special bearings clamped to the overhanging arm, and is connected by stout spur gearing with the regular spindle of the machine. As shown in Fig. 1, the machine is set with the table at right angles for cutting the straight cross grooves which form the ledge for the rail flange. The cutter for this operation is shown centered with the work.

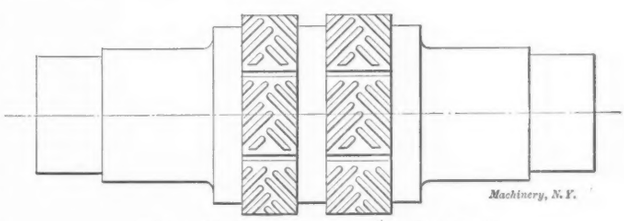


Fig. 3. Diagram of Acting Surface of the Roll.

The diameter of the roll was so great that it was necessary to block up the indexing head as shown. Owing to the great weight and size of the roll, it was, of course, impossible to support it by ordinary means. The arrangement devised for the purpose is clearly shown in Fig. 1, and in the line drawing Fig. 4. The work *D* is mounted in a pair of holders, built on the back rest plan, with bases *E* fastened to the milling machine table. The work is centered and revolved upon three rolls *G* on each side, two being carried by each base *E*, and the others by the upper portion *F* of each support, which is hinged so that it can be swung back out of the way for

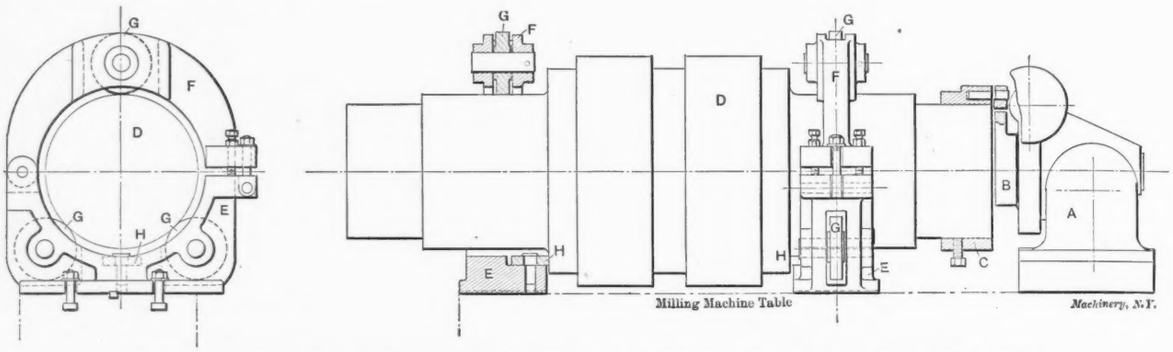


Fig. 4. Arrangement of Supporting and Driving Devices for the Roll shown in Place on the Miller in Figs. 1 and 5.

removing or replacing work. For taking the thrust in the spiral cutting operation shown later in Fig. 5, rollers *H* and *H* on each support are provided, bearing against the shoulder of the journals of the work. To obviate the necessity for accurately centering the work with the dividing head *A*, a flexible driving arrangement is used, consisting of a collar *C* clamped to the driving neck of the roll, and a fork or driver

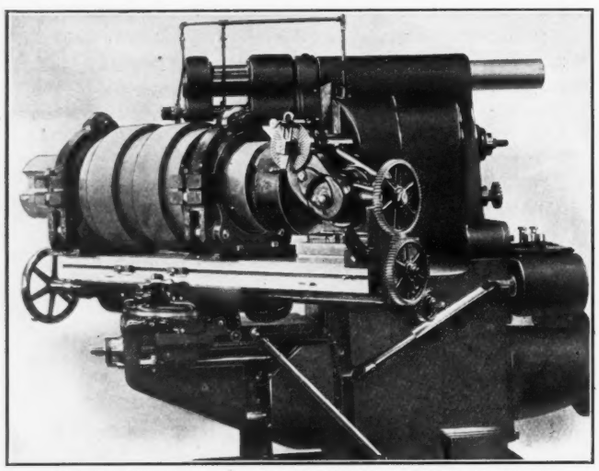


Fig. 5. Milling out the Stock from between the Herring-bone Projections of the Roll.

B, fastened to the nose of the dividing wheel spindle. This driver engages the block shown, pivoted to collar *C*. It will be seen that this arrangement allows for a slight misadjustment of the axis of the work either vertically or horizontally.

The device as arranged for milling the stock from between the spiral or herring-bone projections, is shown in Fig. 5. The same supplementary spindle is used as in Fig. 1, but the table is brought out to center with the work of the cutter on the opposite end of the arbor. Rollers *H*, shown in Fig. 4, now come into action in taking the thrust of the cut while the work is being revolved by the spiral mechanism of the miller.

The machine used is of the regular type built by this firm, which we have previously described in MACHINERY (see "New Machinery and Tools," February, 1907). The drive is through change gearing to give the required speeds and feeds, all of which are obtained from a single-speed pulley. Another feature of the tool is the provision made for constant lubrication of all important bearings by the use of an oil pump and piping system. So far as we know, this firm is the only one to permanently discard the cone pulley and back geared type of machine.

SPECIAL LATHE AND TOOL EQUIPMENT FOR TURNING CONE PULLEYS.

WM. F. GROENE.*

Perhaps some of our friends, who advocate all geared heads or single pulley drives, may consider the subject of this article an antiquated one. Still, here at the R. K. Le Blond Machine Tool Co., we yet have some faith in the cone pulley, and expect that this style of drive will continue to be preferred by most of our customers for some time to come. For this reason, we have been induced to design a machine for doing certain operations in our cone pulleys, and this machine we have recently installed in our shop.

The accompanying half-tones and line engravings, together with the following paragraphs of description, will make clear the construction and operation of this machine, and the tools used with it. The general principle of using multiple tools for turning cone pulleys is not a new one, by any means, but we believe we have embodied in this scheme features and details which are entirely new. The great aim was to produce work of a very high degree of accuracy and truth, at a reasonable labor cost.

The machine used (see Fig. 1) was one of our 30-inch lathes, with head- and foot-stock, "raised in the sand," to swing over the carriage the largest cone pulley we use. This includes all the milling machine cones, and all the lathe cones from 12 to 20-inch swing. The only alterations in the lathe consist in providing a forming attachment for crowning

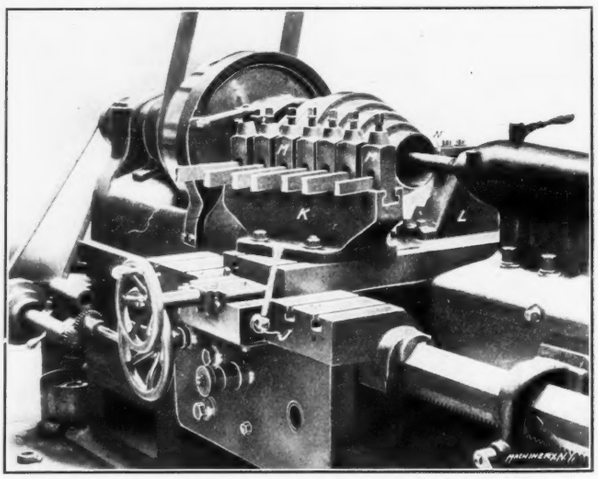


Fig. 1. Lathe with Special Forming Attachment and Tool-holder for Turning Cone Pulleys.

the pulleys, and a multiple tool-holder for finishing the various steps, together with means for holding and driving the work.

The forming attachment will be best understood by reference to Fig. 1, in connection with Fig. 2, which shows a plan and cross-section of the carriage. The cross slide screw *A* is not mounted in the carriage, as usual, but in a square sliding bar *B*, which is seated in a corresponding rectangular recess in the carriage dove-tail, over which the cross slide fits.

* Address: 1311 Delta Ave., Cincinnati, O.

This square bar *B* carries at its rear a pivot, on which is mounted a grooved pulley *C*, which, by a wire rope and a system of idlers, supports the weight *D*, which constantly tends to draw *B* toward the rear. A bracket *E* is fastened to the rear of the lathe bed, having a planed top with a T-slot, in

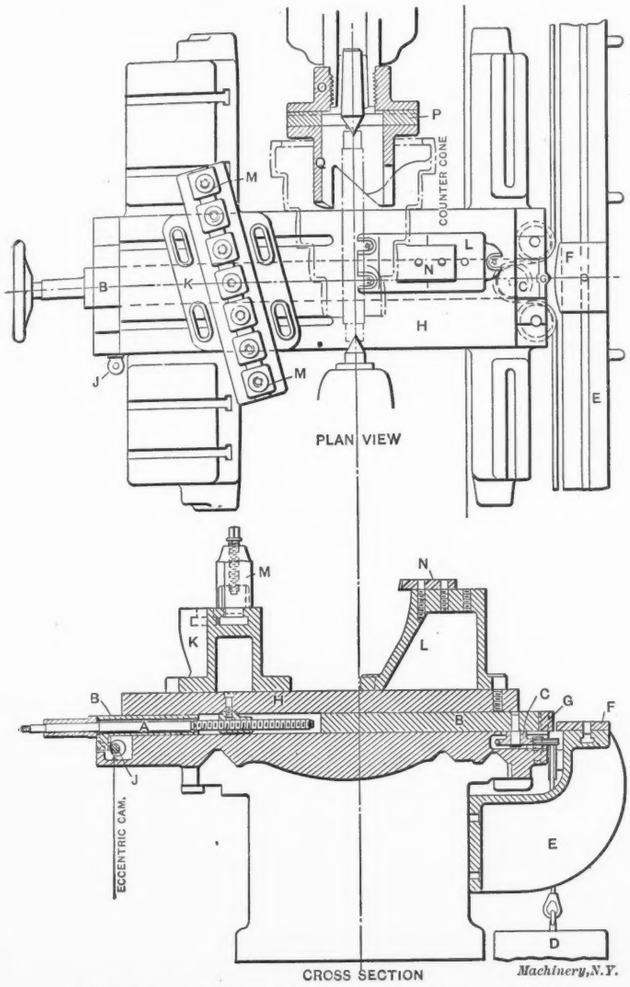


Fig. 2. Plan and Section of Carriage of Special Forming Lathe.

which is clamped former *F*, which has an outline agreeing with the outline of the crown it is desired to turn in the pulley.

A finger, *G*, screwed to the rear of sliding bar *B*, (see also Fig. 4) is pressed in contact with this former by the weight *D*, so that *B* is moved in or out to agree with the contour of the former, as the carriage is operated to the right or left, carrying with it, at the same time, the cross feed screw *A*, and through *A* the cross slide *H*, carrying the tools. An eccentric cam *J*, whose handle is plainly seen in Fig. 1, bears on a downwardly projecting lug at the front of bar *B*, and is used to withdraw it against the pressure of the weight from contact with former *F*.

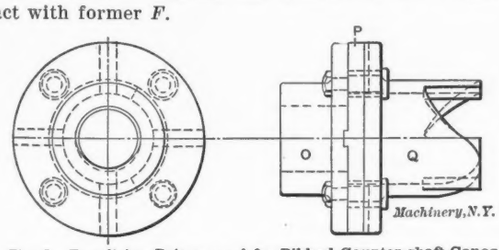


Fig. 3. Equalizing Driver used for Ribbed Counter-shaft Cones.

Two tool-holders are provided; the one in front, *K*, is set at an angle approximately corresponding to the angle of the cone. It carries a T-slot in its upper face, in which are placed a series of tool-posts *M*, each carrying a tool for one of the steps of the cone. The other tool-holder *L* is mounted at the rear of the work, and carries a forming tool *N* for finishing the steps.

The cones are first chucked true with the inside, in one of our 24-inch chucking lathes, and are then bored out with the turret tools. Then, while the outer end of the pulley is supported by a pilot held in the turret, the outside surface of the cone is scaled off all over, with tools held in the turret tool-post on the cross slide. No attention is paid to dimensions, the operator merely following the contour of the casting, taking off about 1/32 inch all over. The pulleys are then hand reamed, after which they are ready for the finishing machine.

The method of turning the counter-shaft cones is shown in Fig. 1, and is also indicated by the dotted lines of Fig. 2. The work is mounted on a plain lathe arbor, as shown, and driven by an equalizing device from the spindle. This compensating driver, shown in detail in Fig. 3, consists of a face-plate *O*, threaded to the nose of the spindle, an intermediate plate *P*, and a driver *Q* having three jaws, adapted to engage with corresponding ribs in the cone. The intermediate plate *P* has horizontal tongues, fitting loosely in corresponding grooves in *O*, at the left. At the right, it has vertical tongues, loosely fitting in corresponding grooves in the flange of *Q*. The clamp bolts which hold *O*, *P* and *Q* together fit loosely. It will thus be seen that *Q* adjusts itself horizontally or vertically, until all three of its driving faces are bearing with equal pressure on the three ribs of the cone, which is thus rotated absolutely without eccentric strain.

Seven tools are shown in place in the tool-holder, turning the five steps of the counter-shaft cone in Fig. 1. Of these seven, five are used to turn the five steps, while the other two are employed to finish the edges of the rim at the largest and smallest steps. The tools for turning are set to a master cone. The slide is raised from the former by eccentric *J*, the tools are set central with the face of the pulley, and the former is set central with the finger, this being done for each new piece of work. The carriage is then moved to the left, the eccentric released and a cut taken over the pulleys.

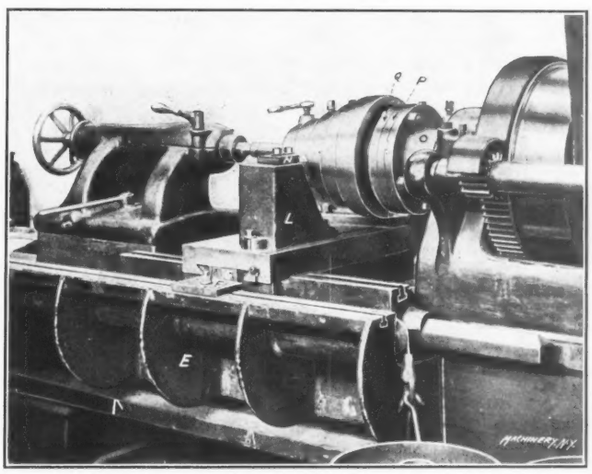


Fig. 4. Rear View of Carriage, showing Form Tool Holder and Form Copying Mechanism.

The next operation consists in scraping the surfaces of the steps with the flat forming tool *N*, mounted at the rear. This tool is ground to exactly fit the previously turned face of the pulley, and takes off about 0.005 inch, enough to remove the tool marks and give a fine finish. It will be seen that this forming tool also has a small lip formed on its left side. This is used for undercutting the sides of the cone steps for belt clearance. By moving this tool slightly sidewise, the proper clearance is cut. This tool, together with the former *F*, and the finger *G* bearing against it, are best seen in the rear view of the lathe in Fig. 4.

In turning the head cones, practically the same turret lathe operations are gone through with as in the case of the counter-shaft cones, the work being chucked and then roughed all over the outside to remove the scale. In addition, the inside is turned, and the step for the cone pinion is bored. The cone pinion is then pressed in, and the pulleys are ready for the finishing machine.

As shown in Fig. 5, the head cones, with the cone pinions

in place, are mounted on the shoulder arbor *R*, and held there by nut *S*. This arbor has a shank at one end fitting the tapered hole in the spindle, while in the other is driven a bronze taper bushing, running on a special hardened center *T* in the tail-stock spindle. The cones are driven from the face-plate *U*, screwed to the spindle, and provided with three driving pins, fitting accurately jigged holes in the inner flange of the cone. These holes are the ones made for the lock plungers.

It will be seen in Fig. 5 that only the four larger steps of the five are turned by the tools in the multiple tool-post. The former does not have to be set centrally with the work for each new piece, as in the case of the counter-shaft pulleys,

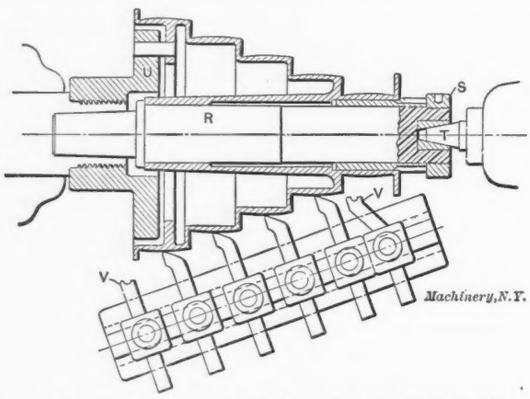


Fig. 5. Method of Driving Head Cones, and Layout of Tools.

since the work is located endwise by the shoulder on arbor *R*. Two extra tools, *V* and *V* are used for finishing the large and small end flanges of the cone. The forming tool *N*, in Fig. 2, is used as before, to finish the crowned surfaces and recess the sides of the steps for the belt clearance. In addition, it turns the periphery of the smallest step, the work being supported stiff enough at this point to allow this heavy forming cut to be taken.

The cones come true to within 0.002 inch, leaving an excellent finish; they require absolutely no filing and practically no polishing.

* * *

Work was begun on the first Hudson tunnel in November, 1874, and continued intermittently until the Hudson Tunnel Co. acquired the franchise and other valuable franchises for tunnels under the Hudson and contiguous shores. The first tunnel projected is rapidly nearing completion, and the opening to traffic from Hoboken to Hudson street took place February 25. Notwithstanding the fact that work was begun on the first tunnel under the waters surrounding Manhattan Island over thirty-three years ago, the first bore to be opened to the public is that under the East River joining Bowling Green with Borough Hall, Brooklyn. This tunnel was opened January 9, and is run in connection with the New York subway. Certain subway trains continue their trips into the Brooklyn district. The new service has to some extent relieved the Brooklyn Bridge congestion, and is the first step in providing more adequate transit facilities between New York and Brooklyn.

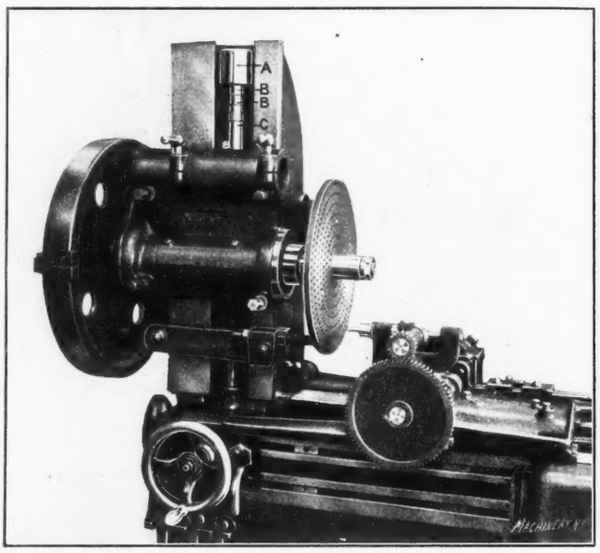
* * *

More than ten years ago, experiments were undertaken by the firm Gabellini, in Rome, Italy, to make boats out of reinforced concrete. Since that time, the firm has built a number of boats for different purposes from this material, these boats having a displacement of from 100 to 150 tons. The frames of the boats are constructed from reinforced concrete, and are covered on the outside and inside with a concrete covering, reinforced with wire netting, water-tight compartments being thus formed between the two layers of concrete. The outside is covered with pure cement, giving a highly finished surface. It is claimed that boats made in this manner have the following advantages over boats built in the usual manner: They can be built quicker and cheaper; the maintenance becomes smaller; they have a high capacity for withstanding outside forces; and, as compared with wooden boats, they are fireproof.

AUTOMATIC FEED-PLATE DRILLING ATTACHMENT.

The accompanying half-tone shows an interesting use for a Brown & Sharpe automatic gear-cutter, it being transformed into an automatic indexing and drilling machine. The scheme is in use in the new shop of the Mueller Machine Tool Co., Cincinnati, Ohio, and is employed for drilling the feed-plates of the variable speed box of the Mueller radial drill.

The drilling fixture is bolted to a No. 3 Brown & Sharpe gear-cutter, the cutter spindle of the latter having a large spur gear, mounted as shown, which drives the small pinion and the drilling shaft at high speed, through the medium of miter gears. The drilling fixture travels automatically back and forth with the machine carriage, in the usual manner, the same as when cutting gears. A lot of 50 or more feed-plates is usually drilled, all in the same circle, and then the index is changed to suit the next concentric circle of holes. The method of making the change is novel. The dial for elevating the dividing head is not used, but instead the exact measurements are obtained by the use of collars or bushings of the exact width required between the concentric rows of holes. A five-pound weight *A* is loosely fitted on top of the elevating screw, and when it rests upon the end of the screw it, of course, turns with the screw when the head is raised or lowered. Between this weight and the elevating screw nut there



Automatic Feed-plate Drilling Attachment.

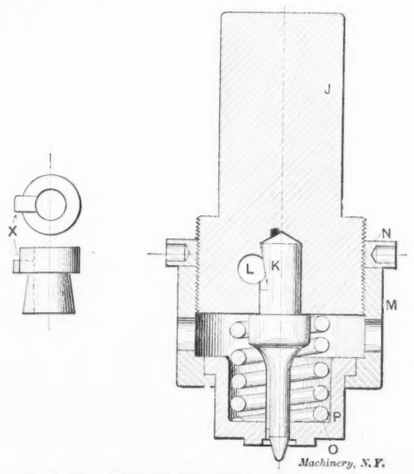
is placed a long collar or bushing *C* having a narrow space knurled. This collar has the exact length required for the elevation of the lower face of the five-pound weight above the elevating feed screw nut when drilling the largest circle of holes. When the next circle is to be drilled in a lot of plates, a collar 0.834 inch in length (which is the distance between the concentric circles) is placed between the long collar and the weight. The method of adjustment is as follows:

The operator holds the knurled collar with one hand and turns the hand-wheel with the other in the direction to lower the dividing head and work spindle. This causes the weight which is supported by the collar and the elevating screw nut, to descend until it touches the end of the elevating screw. The moment it comes in contact it begins to turn, thus notifying the operator that the limit of travel is reached. The same procedure applies for drilling the next concentric row of holes, one of the narrow collars then being interposed between the weight and the long collar. The illustration shows two of these collars on top of the long collar supporting the five-pound weight. It will be observed that the drill is in position for drilling the third row of concentric holes. This method of gaging the width between circles has been found to be close, it being easily possible to space them within 0.001 inch of exactness. It has the advantage of eliminating the mistakes which are always possible in reading graduations on a dial plate.

LETTERS UPON PRACTICAL SUBJECTS.

PUNCH PRESS FORMING JOB.

The accompanying cut shows a rather interesting piece of work done on the punch press. The work to be made is shown in an enlarged scale in Fig. 1. The operation performed with the tool shown consists in forcing the metal out on one side of the piece to form a key, as shown at *X*. The die of the device with which this is done consists of a cast iron block *A*, Fig. 3, bored to receive the tool steel ring *B*, which is tapered on the inside to fit spring collet *C*. The



Figs. 1 and 2. Enlarged View of Piece to be made, and Punch for Forming Key.

set-screw *D* acts as a key and allows the collet to move up and down, but prevents it from turning. The plate *E*, on the top, acts as a stop for the collet, which is forced upward by the spring *F*. Finally, four screws *G* fasten the ring *B* and the plate *E* securely to the die block. The plunger *H* is used for ejecting the piece, being actuated by the spring *I*.

In Fig. 2, the punch-holder is represented by *J*. Into this, tool steel punch *K* is fitted, the punch being driven into its holder, and secured by the taper pin *L*. The sleeve *M*, made

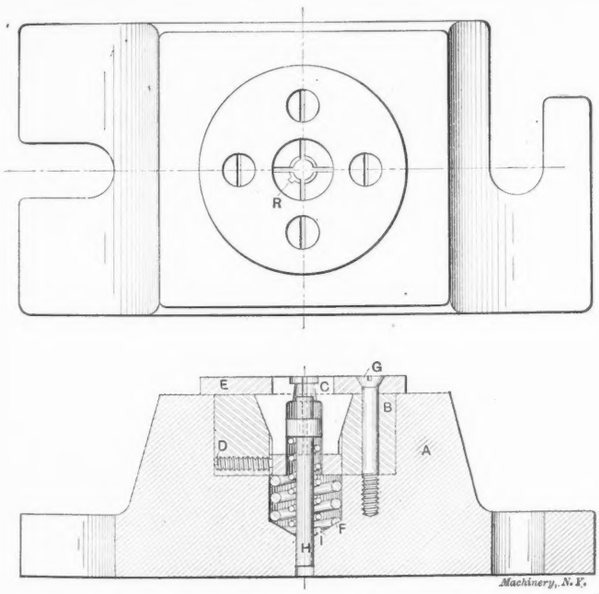


Fig. 3. Die for Forming Key on Piece shown in Fig. 1.

of machine steel, is threaded on the punch holder for adjusting the spring *O*. This sleeve is locked in position by the nut *N*. The cup-shaped piece *P* acts as a stripper, and also closes the collet *C*, Fig. 3, when the punch descends.

The operation of this punch die is as follows: The piece or work, as received from the automatic screw machine, is set into the collet, which is sufficiently open to admit the large end of the tapered part of the work to be put in. The press is then operated. The point of the punch enters the piece, bringing it concentric. The part *P* then strikes the collet, forcing it into the taper ring *B*, and thus the work is held securely while a shoulder on the punch strikes the metal on one side of the piece, forcing it out into the pocket *R*, in the collet, and by this means forms the desired key.

Candiac, Canada. S. A. McDONALD.

WEIGHTS NOT THE EQUIVALENT OF SPRINGS.

Your editorial in the February issue reminds me of the experience of a friend who builds many kinds of hydraulic presses and who, one day, discovered a place in which a weight was by no means the equivalent of a spring.

Some of his presses are equipped with a by-pass valve designed to open when the maximum pressure is reached, and thus prevent accidents. This valve had always been held to its seat by a weighted lever, and had always "functioned" without trouble.

But one day he put to the shop test a press which he had built for a leather-belt manufacturer. It had a large platen for wide belts, and was designed to press together the cemented joints of leather belts in process of manufacture.

In such work the pressure in the cylinder would go up from practically nothing to the maximum, in something like half a stroke of the pump, and then the by-pass valve had to open quickly. It did this by bending the lever on which the weight was placed, the weight itself offering too much resistance to the very quick acceleration required.

The weight was replaced by a helical spring, which was the equivalent of the weight so far as holding the valve to its seat was concerned, but was a very different affair when there was a call for quick opening of the valve, because the mass of the spring was so small as to offer only a negligible resistance, and the valve, though held to its seat by the same pressure, was permitted to open as quickly as was necessary.

On the paper-perforating machine which forms a part of the "monotype" outfit for setting type, there is a suspended weight, which, by its descent, operates certain mechanism intermittently, as the keys of the machine are manipulated. But to the eye, the weight seems to descend, not intermittently, but with a perfectly steady motion when the keys are played rapidly. This is because a portion of the weight-suspending member is a helical spring, which, when the mechanism is released, contracts, and when the mechanism is stopped, expands. Thus the pull is practically uniform, instead of being very small at the beginning of motion and very heavy at the end of it, as it would be if the suspending member were rigid.

The result is another very pretty example of the fact that a weight and a spring are by no means equivalent. I think, generally, when the claim is made that they are equivalent it is meant for the particular case under consideration only; not that the one is broadly the equivalent of the other.

Center Bridge, Pa. FRED J. MILLER.

DRILLING AND REAMING IN THE LATHE.

Your shop operation sheets Nos. 16, 17, and 18 show the old reliable way of drilling and reaming a hole in the lathe. Allow me to offer a quicker, more modern, and even more reliable method of performing said operation.

Take a lathe with a large hole through the spindle and fit to it an up-to-date 3 or 4-jaw geared scroll chuck. These chucks have been wonderfully improved in strength and wearing qualities, and are at present infinitely superior to the old style ring-and-pinion universal chucks. Fit a No. 2 or 3 Hartford or similar drill chuck to the taper hole of the tail-stock spindle, and we are ready to go ahead.

Put the work into the large chuck and face it true. Put a large combination center drill (one with a 7-16 inch body) in the drill chuck and run it in as far as possible—easily at first to make sure it runs true. Follow this with a ¼, 5-16, or ¾ inch drill, according to the size of hole wanted. By thus removing the stock which would otherwise have to be almost

pushed away by the point of the large drill, it is a comparatively easy matter to enlarge the hole to reaming size by means of a twist drill held by the same drill chuck in the tail-stock.

Now about the reaming: I have been told lots of times that a reamer held in the chuck would cut larger than standard, but my experience in this line has taught me that if everything is in line, as it should be, the hole will be straight, true, and as near to size as it is possible to get it by any method. The work may now be turned to size on the outside if required without further adjustment, and if you are one of those fortunate ones who know how to use a cutting-off tool without breaking it, you can finish the piece in one operation without rechucking or placing on a mandrel.

The one point which I would like to bring out most clearly is the utter fallacy (in my estimation) of feeding a drill, reamer or any boring tool into a revolving piece of work by holding it against a pointed center. H. J. BACHMANN.

New York.

LINING LOCOMOTIVE GUIDE BARS FOR LATERAL WEAR.

While visiting several railway repair shops during the past summer, I was particularly struck with the various ways in which the same job was performed. For instance, the manner of fastening liners to steel guide bars, for taking up lateral wear, was accomplished in some places by drilling clear through the guides, and then riveting the liners in place. This takes considerable time, and when a bar requires a liner on each side, some difficulty is met with in getting them both

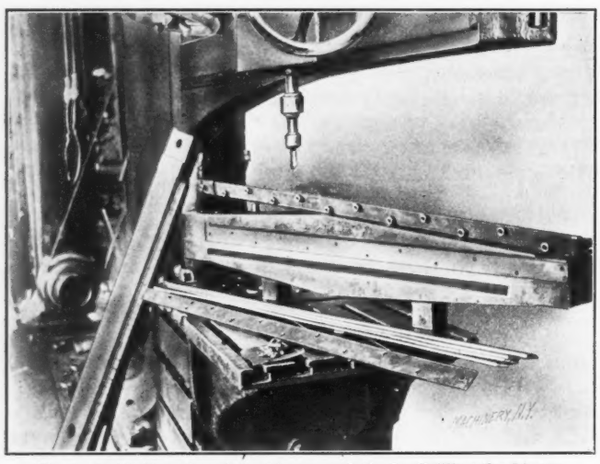


Fig. 1. Guide Bar planed for Liners, and Jig for Drilling the Liners.

tight when using the one rivet for both sides. Others drill and tap holes about one inch deep, then fasten the liner in place by screwing into these holes a length of threaded iron, which is cut off to proper length and then riveted. This does not always make a tight job, and frequently a tap is broken in a hole. Then again, others used countersink screws for holding the liners in place, or, instead of using liners, babbitted the sides of the guides. Of course, in all previously mentioned methods the bars had first been planed certain depths to make room for the liner. I was informed that the babbitted liners wore much longer than the original bar did, and were quickly put on and machined. If this is correct, I am inclined to think this method is better than the others mentioned.

After considerable experimenting, I find the method illustrated in the accompanying cuts to be very satisfactory. In Fig. 1 is shown a bar which has been planed for liners on both sides, the planed surface being 7/32 inch deep and 2 inches wide. Steel liners, ¼ x 2 inches, are drilled to the jig shown, then clamped to the guide bars and the bars drilled with a ⅜-inch twist drill to a depth of ¾ inch. A short twist drill that has been ground so that it is much smaller ⅛ inch back from the point than at the point, and also ground off the center, is inserted in the hole already drilled, and the hole drilled about ¼ inch deeper. A drill ground in this way will produce a hole similar to the one shown in Fig. 2. After countersinking the liners with a long taper countersink, a 5/16-inch steel ball is dropped in the hole and either a brass or soft iron rivet is driven in. While riveting up the top end, the ball is forcing itself up into the slot, which has been sawed in the end of the rivet, causing the rivet to spread and fill the enlarged part of the hole. These liners, if of common rolled bar stock, should be planed after being riveted on; if cold rolled stock is used, this is not necessary, and the recess in the bars should be planed the proper depth

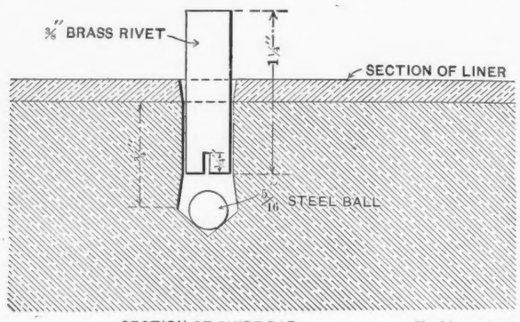


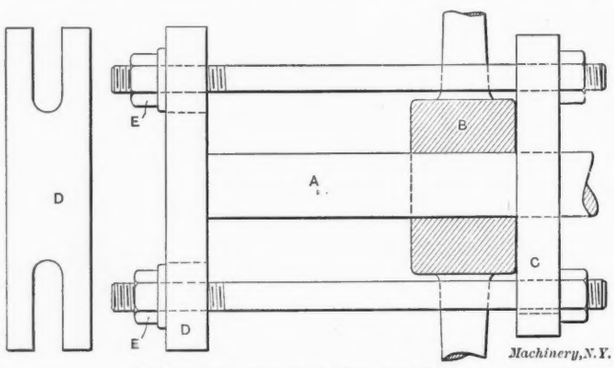
Fig. 2. Method of Fastening Liners to Guide Bars.

to suit the thickness of the liners. This is an inexpensive method ,as the steel balls used do not cost over one-half cent apiece, and there is no tapping of holes or turning and threading bolts or rivets. One end of the liner should be made to butt up against the cylinder head, and the other end to bear tightly against the end of the planed recess in the bar, thereby preventing any shearing strain being put on the rivets. While these liners are not so tight that they cannot be taken off by driving a flat chisel between them and the bars, still, properly fitted endwise, they have held for two years to my knowledge, or until they have had to be removed through wear. M. H. WESTBROOK.

Port Huron, Mich.

TO REMOVE PULLEYS FROM SHAFTS.

The first thing to do when pulleys are to be removed from shafts is, of course, to loosen the set-screws, if there should be any. These are sometimes rusted in, and in such a case it is necessary to use a wrench and pull with a steady pull to avoid breaking off the heads. If the heads of the screws should break off, the only thing that can be done is to drill out the screws. Should the screws be hardened, they can be annealed by means of a blow torch. To remove keys, procure a short, stiff key drift and a heavy sledge. Strike with as heavy blows as possible; light blows are likely to upset the end of the key and make it harder to remove. If it is found impossible to remove the key by this process, a key gun, such



Device for Removing Pulleys from Shafts.

as described in the December issue of MACHINERY, may be used to advantage. If nothing of this kind is at hand, a swinging ram, if there be room to work it, may be used. This may consist of a piece of round iron or steel about six inches or more in diameter, and two feet, or more, long. There should be two eye-bolts in the upper side of this bar, by means of which the ram is suspended from above by a rope, or chain, in such a position that it can be drawn back and swung against the drift. If the key cannot be driven out in this

manner, on account of lack of space, but it can be reached with a drill, it is then necessary to drill it out.

When the key is removed, if the pulley is not very large, or does not stick too hard to the shaft, it may be driven off with a swinging ram. Larger pulleys often have to be pulled off by means of a jack and a long chain; in such a case place the bottom of the jack on the end of the shaft, put the middle of the chain over the top of the jack, and hook the ends around two opposite arms of the pulley, provided these are strong enough to stand the strain; otherwise, place a heavy strap back of the hub, and attach the chain to this. When enough pressure is brought to bear on the jack, a blow with the sledge is likely to start the pulley.

Sometimes a more elaborate rig is required, such as is shown in the cut. In this, *A* represents the shaft; *B*, the hub of the pulley to be removed; *C* is a heavy U-strap; and *D* is another similar strap made as shown in the end view. The size of the bolts and straps used for this rigging, of course, depend upon the size of the work. Three-inch bolts are, as a rule, large enough for any ordinary work, and a wrench may be used, say 10 feet long. The outer ends of the bolts should have a long threaded portion, and suitable washers should be used under the nuts. It is plainly seen from the cut how the pulley is removed, the nuts *E* being tightened up until the hub of the pulley gives away from the shaft. If, however, the hub cannot be started by tightening up the bolts, it may be necessary to heat the hub. Waste dipped in kerosene, charcoal, or blow torches may be used, when necessary, for heating. The rim of the pulley may be protected from the heat by pieces of sheet iron, and the shaft should be kept cool with water.

When a heavy pressure is secured on the shaft, a jar with a heavy sledge is most likely to start the pulley. If, however, the pulley is still fast on the shaft, and no appliances for removing it can be easily secured, then the hub had better be split, and the hole wedged open far enough to let the pulley come off. The pulley can afterward be made "as good as new" by shrinking bands around the hub.

Portland, Me. H. K. GRIGGS.

DRIVING AXLE CENTERING TOOL.

The accompanying cuts illustrate a centering device which may be of interest to the readers of MACHINERY. This attachment is used in the Sedalia shops of the Missouri Pacific Railway. The idea is original, and I do not believe that this device is in use elsewhere. On account of heavy wheel lathe service, we are required to put a 60-degree center, measuring

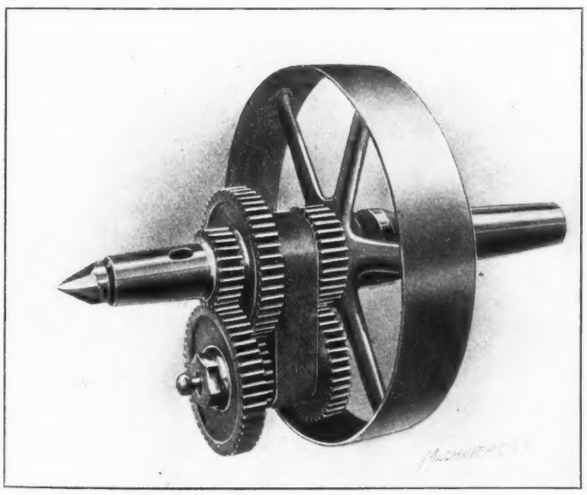


Fig. 1. Lathe Attachment for Centering Heavy Work.

1½ inch in diameter, in all locomotive driving axles. The process of drilling them in with a ratchet was too slow and laborious, and not having a regular centering machine, the attachment shown in Fig. 1 was devised. This attachment works perfectly, producing two large smooth-cut centers in fifteen minutes. The way in which this device is attached to a lathe is clearly shown in Fig. 2. The lathe center is removed, and the spindle of the machine is inserted into the tail-stock of the lathe. A separate counter-shaft is provided with a "Sim-Pull" starting device, and by changing the position of the pin *A*, shown in Fig. 3, two speeds are obtainable, one giving 75 revolutions for the countersink, and the other 300 revolutions for a ⅜-inch drill which precedes it. A 2½-inch belt is used for driving, and as there is but four inches

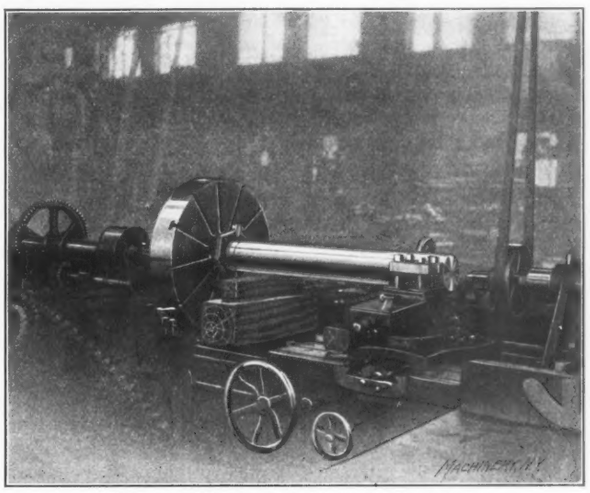


Fig. 2. Centering Tool attached to the Lathe.

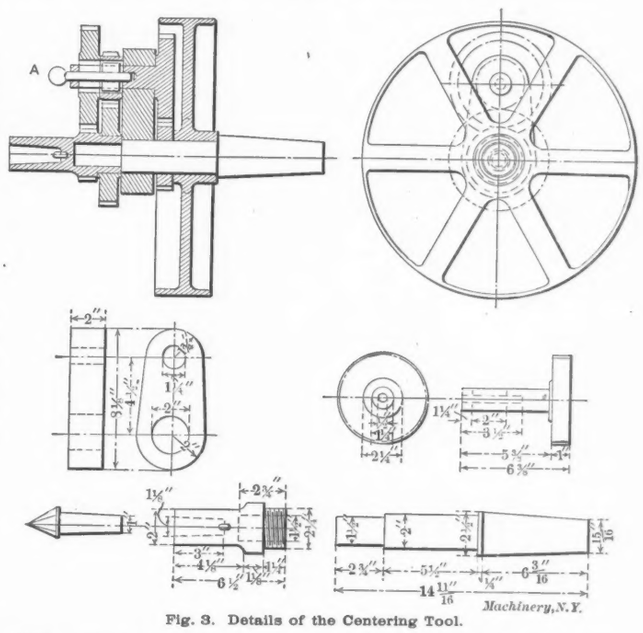


Fig. 3. Details of the Centering Tool.

difference in the length of all the axles in use here, a 10-inch face fully on the counter-shaft gives ample room for the variations. W. W. WILLIAMS.

Sedalia, Mo.

MAKING A SLEEVE WITH AN ACCURATE KEYWAY.

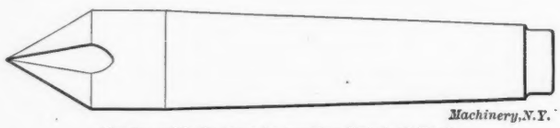
One day a job came up requiring the making of four high-percentage chrome nickel-steel sleeves, 9 inches long, having a 1¼-inch bore, with keyways 3/16 inch wide by 3/32 inch deep. The sleeves must be made so that they would slide on the shaft freely, and yet have no play. The bore was to be within 0.0005 inch of the correct size and the key way to be exactly parallel with the bore. This job was completed in the following manner. The bar steel for the sleeves was held in a chuck near the end and rough-turned on the outside, and provided with a 1 3/16-inch drilled hole. It was then taken out of the chuck and a 1-inch bore collet was fitted to the taper in the spindle of the lathe, and a cast iron boring bar holder fitted to the carriage and bored with a 1-inch drill, held in the chuck,

so as to be parallel with the head-stock. A piece of cold rolled 1-inch shafting was then provided with a square cutter held in place by a set-screw on the side and fed out by a set-screw on the top of the bar, acting on the end of the cutter. The sleeves were then rechucked and bored to 1.240 inch diameter, and then the cutter bar was inserted in the boring bar holder and brought carefully to the center, and the carriage clamped to the gib screws. A slotting cutter, ground to gage, was inserted in the bar, and the set-screw on the side was tightened just enough to hold the cutter firmly in place and yet allow it to be pushed out by the adjusting screw after each cut to provide for feed. The carriage was then run forward and back by hand, each cut taken being about 0.003 inch deep, using lard oil on the cutter. The sleeves were then placed on a mandrel and finished on the outside. The bore was lapped to size with a lead lapping bar cast on a tool steel mandrel, turned to about 1.180-inch in diameter. This procedure resulted in a perfect job.

Schenectady, N. Y. ROBERT MAYHEW.

CENTER USED WHEN FACING THE ENDS OF WORK.

I have been greatly interested in the letters in MACHINERY regarding the squaring of the ends of work on centers, and it may be of interest to some readers of MACHINERY to see the simple center that I use for this purpose. This center may not be new to everybody, but I have never seen this idea published in any trade paper before. On the side of the center is a half round groove as indicated in the cut. This groove



Center with Groove to receive Point of Tool.

is made by a round file, and while the efficiency of the center for ordinary work is hardly impaired at all, it is possible to use a tool that is quite blunt on the end when facing work; by feeding the tool to the bottom of the groove, the work can be cleaned perfectly at the end. The edges of the groove should be slightly rounded, so as to prevent all tendency for cutting or reaming the center hole of the work.

Newburyport, Mass. R. H. MARSH.

NOTES ON CENTERING.

The remarks by "Allan" in the October, 1907, issue regarding centering work for turning has just caught my attention, and I would like to add a few words. What "Allan" writes is all very good as far as it goes, but in my estimation "the half has not been told." The balance of the story is this: Keep handy a punch ground accurately to 60 degrees and fairly long and stout. After the center has been reamed, clean out the hole thoroughly, then set in the punch so that it stands vertical, and give it a hard blow or two with a fairly heavy hammer. To prove that this method is necessary, center a shaft, omitting the punching. Take a heavy cut half way over the piece. Turn it end for end and start another cut. Where the cuts meet, it will be shown that two ends of shaft are not concentric in nine cases out of ten. Now, take another piece and punch as described above, turn as in the other example, and you will find the result more satisfactory.

Another kink I always use and which I believe is not widely known (having been asked by different foremen more than once, "Now, what are you doing that for?"), is to grind a fine, narrow groove lengthwise on the dead center. Set the center with the groove on top or a little to the rear. This prevents disagreeable happenings in the shape of pieces dropping down between the lathe ways when you are loosening the center to oil it, or when the center gets hot. With this groove you can oil the center at any time and its life is much prolonged.

As "Allan" aptly remarks, the centering is of the utmost importance. The angle of centers must be perfect because of the extensive use of the grinding lathe in modern manufacturing, and the attendant changing of the shaft from one machine to the other. Where there is a grinder it is best to have a special collet or bushing in which to grind lathe centers. Some argue that a center should be ground while in place in the spindle, but in modern lathe building practice it is waste of time, for the center will invariably run true without having to be scratched or center punched to correspond to a certain place on the lathe spindle.

PLODDER.

[We are impressed by "Plodder's" faith in the absolute concentricity of lathe spindle taper holes with their bearings, but think that it is wise to demonstrate the fact on each lathe before accepting it as the gospel. In a later letter "Plodder" explains that the use of the special 60-degree punch is to condense the metal around the center hole and thus prevent rapid wear. If the practice is followed it is obvious that great care should be taken to set the punch perfectly in line with the piece being centered so as not to distort the center.—EDITOR.]

FACING WORK ON CENTERS.

Having noticed, recently, several suggestions relative to the facing of work on centers, it has occurred to me that a method I have used for some time may be of interest to the readers of MACHINERY. After drilling the centers and before countersinking, put the piece in the lathe and face as close to the center as is convenient with an ordinary side tool; then finish the center, cutting off the thin shell that is left around the drilled hole with the countersink. By this method one avoids using an extra center, and the work is square on the end before the countersinking is done, which is a considerable advantage, since, if such is not the case, the high side tends to push the countersink out of line with the drilled hole. Another way is to face the ends while the piece runs on punched centers, before they are drilled, and sometimes this does very well, saves a little time, and makes an end square enough for the purpose, but it is not as accurate as the former method, since it is not at all certain that the center, when finished, will have the exact location of the punched hole.

C. H.

A RULE FOR OBTAINING THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC.

In the December issue a correspondent asked how to obtain the height of the middle ordinate of an arc, having given the chord and the angle at the center. Here is my rule:

Divide half the chord length by the sine and by the tangent of half the angle at the center. The difference between these

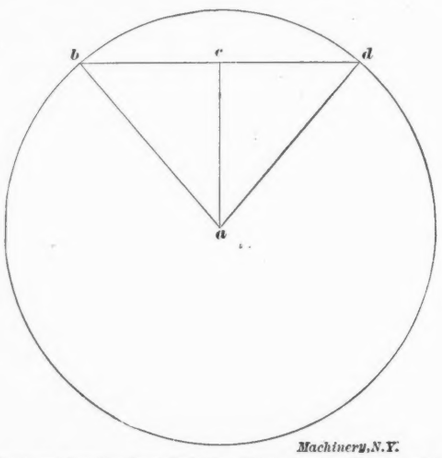


Diagram showing how Rule for Obtaining the Height of the Middle Ordinate is Derived.

two results is the height of the ordinate. A reference to the diagram will show how this rule is derived.

Bisect the angle at the center by the line *a c*. We now have two triangles *a b c* and *a d c* with sides and angles equal. Taking one triangle *a b c*, it is evident that the required height is the difference between the hypothenuse *a b* (the radius of the circle) and the side *a c*. Now *a b* is equal to *b c* divided

by the sine of the angle $b\,a\,c$. And $a\,c$ is equal to $b\,c$ divided by the tangent of the angle $b\,a\,c$.

In the problem which you used as an illustration, the chord was equal to 10 feet and the angle at the center 36 degrees. Using these values, $b\,c$ equals 5, and angle $b\,a\,c$ equals 18 degrees. Now 5 divided by 0.30902, the sine of 18 degrees, equals 16.1801. You obtained 16.55 for this value. This was erroneous, the error being made in solving the equation $0.30902\,R = 5$. Dividing 5 by the tangent, 0.3249, we have 15.3892 as the length of the side $a\,c$. Subtracting, 16.1801 minus 15.3892 equals 0.7909 foot, the height of the ordinate.

F. M. S.

[The method given by F. M. S. is undoubtedly the more elegant of the two, although the operations are the same in number, *i. e.* three. It is generally easier to multiply numbers than to divide them, especially when the divisors contain five or six figures, part or all of which are decimals. For this reason some may prefer the method given in December.—EDITOR.]

SHADING DRAWINGS.

To what extent it is desirable to shade the curved surfaces shown on working drawings, giving more or less resemblance to the appearance of a wood engraving, is a question occasionally calling for a decision in the drawing-room. The question is usually decided by the chief draftsman in favor of no shading at all, in view of the appreciable amount of the draftsman's time required to do the extra work, involving an additional labor cost. The additional advantages of a judicious amount of shading is entirely lost sight of in the light of the extra drawing-room expense incurred. While it is important for commercial reasons that labor cost should be kept at a minimum, it is questionable economy to keep down this cost at the expense of absolute clearness, especially so when the resulting drawing may go distances varying from 300 feet to 300 miles, or more, away, passing into the hands of unknown workmen, with more or less doubtful ability to properly read and comprehend all of the details involved. There are many to whom the lines and details of a working drawing are a meaningless mass of confused lines and figures, entirely beyond comprehension, while a wood engraving is clearness itself, instantly presenting the object in an unmistakable manner, with the least possibility of misunderstanding. It is unquestionably a fact that the major part of all machine drawings would be a great deal clearer, easier and more quickly read were a judicious amount of shading properly done in their preparation. The slight extra cost being many times offset by the saving in correspondence and time used in asking questions, and in running about making the necessary explanations, which, were proper shading done, would be, to a large extent, eliminated.

Being in charge of drawing-room on a class of work requiring many complicated assembled drawings, which are distributed among men of varying degrees of ability in the quick and accurate reading of drawings, the need has been felt for some means of bringing out more clearly the forms of the various parts, which has been done with very satisfactory results by the adoption of a generous amount of shading of curved and irregular surfaces. This resulted in a very marked decrease in the number of inquiries received, and explanations necessary to be made, and also in a considerable saving in the time of a high grade man, which was formerly used to an appreciable extent in running around a large factory in the capacity of a walking encyclopedia. While it is not practical to duplicate a wood engraving in its completeness, yet there is undoubtedly a point between this extreme and that of the ordinary working drawing which it is economical to reach, notwithstanding the extra drawing-room cost incurred.

H. D. PENNEY.

Pittsfield, Mass.

[The time required in the drafting room to make simple shade lines to indicate the lower and right-hand edges of solids is time well spent. When a drawing is properly dimensioned, every distance that the workman will need to know being given, there can be no objection to such shade lines other than the time required to make them. The time dwindles into insignificance when the clearness and attractiveness of drawings properly shaded is taken into account. In the course of a year we see a great variety of drawings made by all kinds of draftsmen trained under all sorts of conditions. The difference in clearness is amazing, and it is easy to see that simple shading and proper cross-sectioning are really very important. The drawing that possesses snap and life is an inspiration, and it is a real pleasure to work from it. The unshaded drawing has a weakness and dullness that is discouraging. It requires more mental effort or concentration to understand it, and the chances for error of interpretation are greater, we believe, than with shaded drawings. As to shade lines for rounded surfaces, however, we doubt that they are generally advisable. Unless such shading is *very well* done, the result is decidedly amateurish in appearance. If it is well done the effect is, of course, pleasing and the subject stands forth clearly, but unless for some very special cases, we would not favor it.—EDITOR.]

GERMAN MANUFACTURERS HELPED ONLY BY REDUCED FREIGHT RATES ON EXPORTS.

In your leading editorial in the November issue, 1907, entitled "The French Machine Tool Trade," you claim that the German tool manufacturers receive an allowance from their government on all machinery sales for export. This statement is certainly not based on fact, and it seems to have emanated from certain sources which constantly endeavor to create ill feeling against the nation that is one of America's best customers.

The only way in which the German government favors export is by allowing a slightly more favorable *freight* rate on goods exported than on those imported, which, however, is quite a negligible quantity, and it certainly does not handicap the American builders. The import of American machine tools in Germany and other continental countries is, as you must be aware, more handicapped through the excessive American duties which have made treaties on a mutually fair basis practically impossible. The result is that American machinery has lately been deprived of the very advantageous tariff rates ruling under the "most favored nation" clause, and pays now here in German nearly double the former rate. I note that the National Association of Machine Tool Builders lately decided to maintain prices regardless of the falling-off demand; while such a move may be practicable in the United States, it is essential for the maintenance and development of the American machine tool trade in Europe that such artificial prices based on an excessive tariff and resulting high cost of material and labor, are not imposed upon the European market.

FAIRPLAY.

Charlottenburg, Germany.

WRITING TO GERMANY.

Referring to item on page 232, engineering edition, in regard to foreign postage for replies; why not use a postcard with paid reply (cost 4 cents), or get, at your local post-office, an international reply coupon for six cents, which will buy a 20-pfennig or a 25-centime stamp in the country of the receiver? United States stamps are of no use to Germans. What would Americans do with German stamps? If Americans would pay full postage on their sendings, it would be better. Many a letter containing an offer is refused because the addressee will not pay 40 pfennigs on a sending of unknown contents.

ROBERT GRIMSHAW.

Dresden, Germany.

HARDENING SPRING COLLETS.

In reading an article by Mr. J. J. Voelcker, in the December issue, regarding the making of spring collets, it occurred to me that it might be of interest to some of the readers of MACHINERY to know how the writer hardens them. I have been hardening tools of this character for the past eight years, and have had no trouble with breakage, which I attribute to slow and even heating.

In the first place, the collets are heated evenly all over, using a section of pipe closed at one end, if heating in a forge. I then take the collets, one at a time, put them on

end, and insert a taper plug in the hole, pressing it in until I get the required expansion, in a manner as shown in the half-tone, Fig. 1.

Sometimes one slot will not open as readily as the others, the reason for this being that the collet is slightly cooler in one portion than in other parts, making it somewhat stiffer. To overcome this, I insert a thin chisel in the narrow slot, carefully pressing inward until I get the slots about equally open. I then leave the plug in the collet until the latter is cold. When I heat them for hardening, I set them on end in the furnace. If heating them at the forge, I make a small taper piece of iron, about one inch long, and insert this in the hole at the jaws, previously having taken out the expanding taper plug. This small piece keeps the sections of the collet from closing up, which they naturally would do if placed on their sides in the forge. They should be frequently turned around in order to heat them evenly. When the collets are hot, the plug is easily and quickly pushed out from the back end with a rod or wire; then the collet is dipped into the bath.

Fig. 1. Inserting Taper Expander into Collet.

When dipping, the collets should be immersed in the bath up to the shoulder or a little more, and when cold enough to have secured the necessary hardness, they should be withdrawn quickly from the bath and plunged in lard oil. When cold, they are polished from the shoulder to the back end, and then drawn to 400 degrees F. in the oil furnace; finally, the back end is drawn to a dark blue on a heated plate, running this color about half way up on the collet. Then the collets are cooled in oil.

Machine steel collets are expanded in the same manner, and then packed in a suitable box, as indicated in the line cut, Fig. 2, the packing consisting of a mixture of No. 2 raw bone and burnt bone, that is, bone that has been used once. The collets are packed in pairs, about one-half inch apart, and there should be about one inch of packing between the collets and the walls of the box. The cover is then put on the box, and luted with fire-clay. The box is then put in the hot furnace and heated slowly to 1300 degrees F., and kept at that temperature for about three hours. It is then removed from the furnace, the cover taken off, and the jaws of the collets plunged first in water and then in lard oil. When cooled off, the collet is polished, drawn to a deep blue, leaving the jaws as hard as when they came from the bath. Care should be taken that the heat does not exceed 1300 degrees F., as it makes the collets brittle if subjected to a higher heat. If the collet is a long one, the color is drawn to about 1½ inch above the end of the slots. The writer's experience indicates that machine steel collets give fully as good satisfaction as tool steel collets when the cost and the greater ease of making is considered.

It may be somewhat difficult to get the right heat when case-hardening the collets. A good method is to drill two or three holes in the top of the box and insert some nails long enough to reach to the center of the box. These nails can be withdrawn when it is estimated that the box is heated all through, the heat of the nails observed, and the heat inside the box estimated accordingly.

The box used may be made very simply and inexpensively from sections of 3, 4, 5, or 6 inch pipe, as the case may be, and should always be two inches longer than the work to be hardened. A cover is welded on one end, and the other end has a cover with a lug or eye riveted to the center, making it easy to handle. These pipe boxes, if flattened, as shown in Fig. 2, become somewhat more useful. It is well to pack the collets with the back ends toward the open end of the pipe, as it makes it easier to take them out and dip them. Care should be taken, when pulling out the collets not to uncover those still remaining, but if one of them becomes exposed, cover it with hot bone dust, so as to keep the heat until ready to remove the next collet.

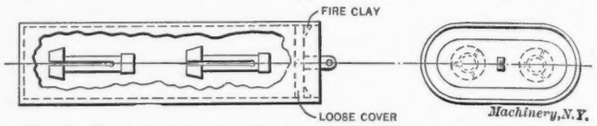


Fig. 2. Method of Packing Machine Steel Collets for Case-hardening.

GEO. T. COLES.

Decatur, Ill.

KILLING MEN AND FINING EMPLOYERS.

As to killing men and fining employers, referred to in the December issue on page 233, engineering edition, the majority of fatal accidents are caused by the men. As a boy I lived near a gunpowder works. The men were forbidden to enter a grinding mill before stopping the machinery from the outside; to wear boots with iron-pegged soles; or to use iron hammers in coopering up the powder. They did all three (smuggled iron hammers in under their blouses) and caused many explosions. They wrecked part of 15th Street, Wilmington, Del., by smoking in one of three eight-mule wagons loaded with gunpowder. I have known workmen in rubber-mills to put pennies on the rolls and bet 10 cents that they could get them out before they went through. Sometimes they didn't, and lost an arm. ROBERT GRIMSHAW.

Dresden, Germany.

DIE FOR BENDING COLD ROLLED STEEL PIECES.

The tools shown in the cuts herewith are designed for bending ⅜-inch round cold rolled steel pieces to the shape shown at *E*, Fig. 1. The chief consideration in the manufacture of these parts is the reduction of the cost, and the elimination of as many operations as possible, yet maintaining the accuracy required, which, in this case, is very close, the opposite sides of the work having to be almost parallel, the ends not to be spread more than 0.002 inch. The type of die shown, for bending the piece in one operation, is being applied with great success, and can be highly recommended for its pur-

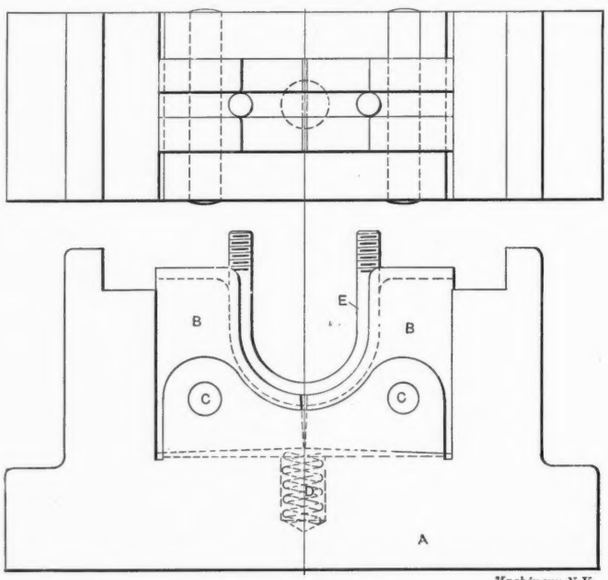


Fig. 1. Die with Completed Work in Place.

pose. While the tool was devised primarily for the purpose of bending the work mentioned, it can be used to advantage for flat work of similar shape, especially for metals of an elastic nature, when it becomes necessary, in order to obtain desired results, to make allowance for the spreading of the ends after bending.

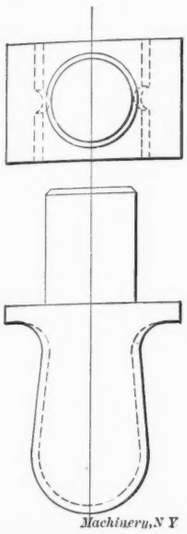


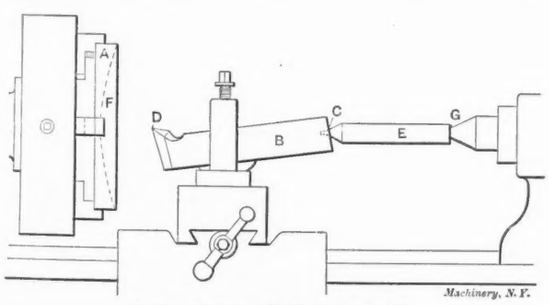
Fig. 2. Punch for Bending Cold Rolled Steel.

Fig. 1 shows the die, consisting of the cast iron holder *A*, the upper parts of which are machined to act as a gage for the stock, the steel jaws or dies *B B*, which are made of tool steel, hardened, and ground to dimensions, and have the holes lapped to an easy fit on pins *C C;* and the spring *D*, which is required to open the die as the punch ascends. The holder should be machined to permit the opening of die sufficiently to release the work, and permit the easy removal of the finished piece by the operator. Fig. 2 shows the punch, made of high carbon steel and hardened, and having a groove on the sides and lower end, of a radius to accommodate the work. The cuts show very plainly the construction and action of the device. It may be further stated, however, that, in adjusting the press ram, it should be brought down sufficiently to tip the die members, and bend in the ends of the work a certain distance. This is required to compensate for the springing back of the metal when the punch ascends.

ENGINEER.

FACING CONCAVE WORK IN THE LATHE.

It is quite often necessary in machine shop practice to turn out concave disks for various purposes. This work of course, can be done on turret lathes with the aid of forming tools, but the manufacture of an outfit for this purpose is too expensive when only a small number of pieces are to be made. The following method will be found to be very satisfactory and cheap, as the apparatus, if constructed properly, will finish the work so closely that it will require little or no scraping to fit it to gage: Chuck the piece *A* in the required position, and after centering the tool *B* at a point *C*, set the tool so that points *D* and *C* are in line with the head- and tail-stock centers. Take a piece of cold rolled steel *E* the same length as the radius of the concaved surface *F*, and point one end the same as a center, and center-drill the other end. Move carriage of lathe so that tool *B* is close enough to the work to take a cut of sufficient depth. Place the point of the piece *E* in the center *C*, and draw up the



Facing Concave Work in the Lathe.

tail-stock bringing the center in *G*. Clamp the tail-stock securely. Start up the lathe and feed the cross-slide either by hand or power. The piece *E* may be made in two parts by using a right- and left-hand union nut with check nuts to hold the union nut in position. This will allow of adjustment in the piece *E*.

W. J. SANSOM.

Madison, Wis.

[Of course it will be seen that if the lathe has a compound rest it is not strictly necessary to place the radius piece between the end of the tool shank and the tail-center, although this is the most convenient position, no doubt. We, therefore, venture to suggest a variation of this ingenious scheme that has an obvious advantage. If we make the radius piece pointed at each end, and support it in prick-punch marks in the cross-slide and tail-stock base, it will guide the tool point in exactly the same arc as though used in the manner illustrated, provided it is properly aligned to begin with. This being so, the same plan may be followed in turning convex surfaces, by simply placing the double point radius piece between the cross-slide and the head-stock. It will not work so well because the pressure of the cut will tend to push the carriage from the radius piece, whereas on concave facing the pressure of the cut is against the radius piece. However, for light finishing cuts it should work fairly well.—EDITOR.]

CONSTANTS FOR FINDING SPEEDS OF DRILLS.

The accompanying table contains constants which have been figured for facilitating the calculation of the speeds of drills. These constants will be found useful for finding the speed in feet, when the number of revolutions is given, or the number of revolutions, when the speed in feet is given. Thus, the figure in the column opposite the size of drill will, when multiplied by the number of feet per minute, give the required number of revolutions for the given speed in feet for this size of drill. Used in the reverse order, when the number of revolutions is given, dividing by the number opposite the size of drill will give the speed in number of feet per minute. Suppose, for instance, that it is wanted to run a 3-inch drill, at 40 feet per minute; then, multiplying 40 by the constant 1.27, given opposite the size of drill in the table, gives us 50.8 revolutions per minute. In the same manner, if it were known that a drill was running at 51 revolutions per minute, by dividing by the constant 1.27, for a 3-inch drill, we would get the running speed as 40 feet per minute, approximately.

TABLE OF CONSTANTS FOR FINDING SPEEDS OF DRILLS.

$$\text{Constant} = \frac{12}{\text{size of drill} \times 3.1416}$$

Constant × speed in feet = number of revolutions.

$$\frac{\text{Number of revolutions}}{\text{constant}} = \text{speed in feet.}$$

Size Drill.	Constant.	Size Drill.	Constant.	Size Drill.	Constant	Size Drill.	Constant.
1/8	30.55	15/16	4.07	1 3/4	2.18	2 9/16	1.49
3/16	20.35	1	3.81	1 13/16	2.10	2 5/8	1.45
1/4	15.27	1 1/16	3.59	1 7/8	2.03	2 11/16	1.42
5/16	12.22	1 1/8	3.39	1 15/16	1.97	2 3/4	1.39
3/8	10.175	1 3/16	3.21	2	1.91	2 13/16	1.36
7/16	9 09	1 1/4	3.05	2 1/16	1.85	2 7/8	1.33
1/2	7.64	1 5/16	2.91	2 1/8	1.79	2 15/16	1.30
9/16	6.78	1 3/8	2.77	2 3/16	1·74	3	1.27
5/8	6.11	1 7/16	2.65	2 1/4	1.70	3 1/16	1.24
11/16	5.55	1 1/2	2.54	2 5/16	1.65	3 1/8	1.21
3/4	5.08	1 9/16	2.42	2 3/8	1.61	3 3/16	1.20
13/16	4.69	1 5/8	2.35	2 7/16	1.57	3 1/4	1.18
7/8	4.37	1 11/16	2.26	2 1/2	1.53	...	....

Worcester, Mass. PETER PLANTINGA.

COMMENT ON UNIVERSAL VISE.

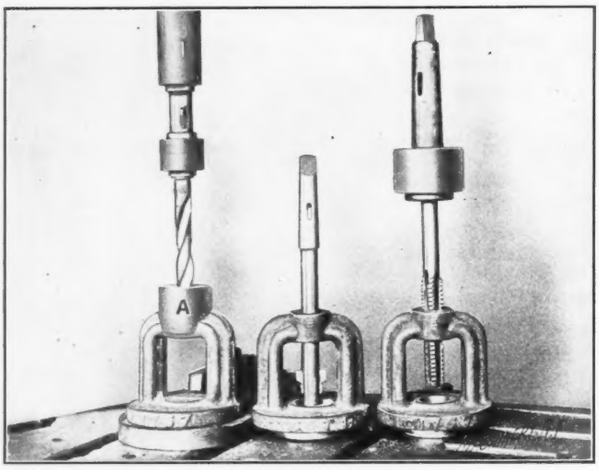
A machine vise having a ball and socket joint like that illustrated in the January issue of MACHINERY was used by the writer in 1887 in Battle Creek, Mich. The vise was employed principally in drill press work, and while the idea was apparently all right from a theoretical standpoint, the thing did not work satisfactorily in practice. In leveling up work, a blow of the hammer in one direction nearly always caused the vise to go down in a slightly different direction, making it a tedious job to get a piece of work properly adjusted. The trouble was probably due to some irregularity in the ball. In making such a vise, the ball should be turned in connection with the compound rest, or with a ball-turning attachment. If neither of these is available, the gage that is used to test the ball should be bored true in the lathe rather than filed to marks. The bearing in the socket may be made by pouring babbitt around the ball, and probably it would be a good idea to tighten the clamping bolts slightly while the babbitt is cooling.

W. S. LEONARD.

Atlanta, Ga.

DOING LATHE WORK ON A DRILL PRESS.

The accompanying cut illustrates how a cast iron hydrant yoke, which was formerly machined in the lathe, is done on a drill press with a great saving in time and money, the cost being reduced from fifty cents to five cents each. By referring to the cut, the method of doing the work will be readily understood. First a cast iron plate was turned to fit the hole



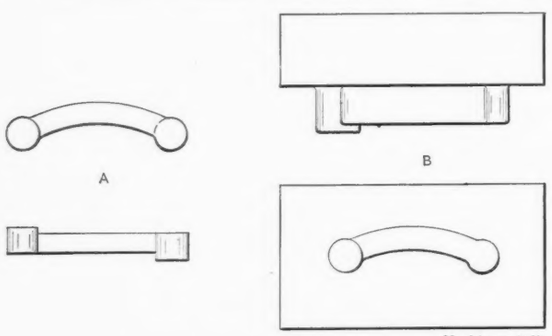
Method of Drilling, Boring and Tapping Hydraulic Yokes on the Drill Press.

in the drill press table, and the upper surface of the plate recessed to receive the projecting bottom of the yoke. When a yoke is to be machined this casting is driven into the table, and the yoke securely bolted to it. The steel cap *A*, which fits around the boss on the yoke, is then placed on it as shown, and a hole drilled central for threading. A bar is then put in the spindle and passed through the hole, and a high-speed steel cutter is inserted into the slot, and the stuffing-box bored. Next, the special tapping socket is put in the spindle, and the hole tapped, the tap being taken out through the hole in the table. The base-plate and table are securely fastened in one place during the operation, and it is not necessary to move the drill spindle sideways after once starting the job. The castings were afterwards placed on a mandrel and the bottom faced off in a lathe. This is but one of many instances where I have found that by paying attention to special devices, I have been able to do good every-day lathe work on the drill press at less than one-fourth the cost.

Port Huron, Mich. M. H. WESTBROOK.

HOB FOR FORGING DIES.

In the accompanying cut, a forging of which a great number is to be made, is shown at *A*. As dies for making this forging, it being produced in such great quantities, have to be renewed quite frequently, the making of forging dies in the usual manner becomes quite expensive. In the shop



Forging, and Hob for making the Die.

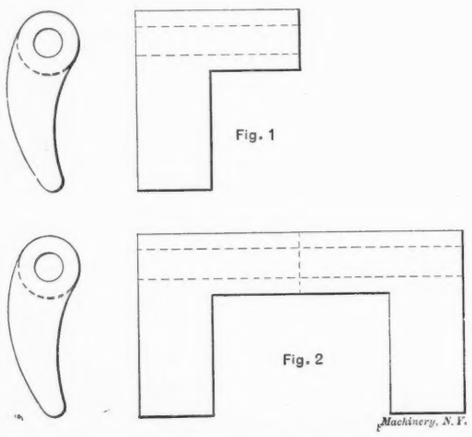
where these pieces are manufactured, however, the expense of making new dies is greatly reduced by making a hob, such as shown at *B* in the cut. This hob is made of tool steel and hardened, and has a projection of exactly the same shape as the piece to be forged.

The block for the forging die, in which the shape of the piece to be made is to be formed, is placed, together with the hob, in correct relationship in a hydraulic press, and the hob forced into the die block the required depth by hydraulic pressure. By forcing the hob into the die block, the metal displaced is thrown up around the side of the hob. This surplus metal is removed, and the die is hardened. By making dies in this manner, it is possible to renew the dies at a fraction of the cost of dies made in the ordinary way. For irregular shaped forgings it is sometimes necessary to make two hobs, one for the top and one for the bottom die. FRED R. CARSTENSEN.

Montreal, Canada.

AN EXAMPLE OF MISPLACED ECONOMY.

The accompanying cut shows an example of how the mad rush to try to accomplish a saving in the cost of a product, when accompanied with too little forethought, often plays a trick on its originator and causes an additional, rather than a reduced expense. Things of this kind, perhaps, do not happen very often, but the case in hand has actually taken place



The Piece to be made, and the way the "Saving" was accomplished.

in one of the largest machine shops in the country. A little detail, such as shown in Fig. 1, was required to trip a lever on an automatic machine. The foreman of the department detailed to make these pieces, who, by the way, receives a liberal allowance on the contract price for the work carried out, provided he can cut down the expense of producing the work to a low limit, conceived a brilliant idea of making these pieces "two in one." The pieces were first to be drop forged, being finished only on the portions that worked against other surfaces, and he placed an order for drop forging dies to make pieces such as shown in Fig. 2. When cut apart in the middle, on the dotted line, there would evidently be two pieces made practically at the cost of one, if the price of material is not considered. Enormous quantities of these little details were drop forged, machined, drilled, cut apart, and case-hardened, when it was finally detected that one-half of the number of pieces became left-handed, and therefore, by necessity, had to make a bee-line for the scrap box. T. O. OLMAKER.

TOOLS MADE FROM FILES SHOULD BE ANNEALED.

Among the "Practical Don'ts for Machinists" published in the January, 1906, issue, we found one that said: "Don't forget that a fairly good center-punch can be made from a piece of round file." This statement should be qualified by the caution that the end which is to be struck with the hammer should be annealed. The danger of striking hardened steel with a hammer is well known. Three machinists with whom we are acquainted here in Waterbury each lost an eye by striking hardened steel with a steel hammer.

Waterbury, Conn. HENDERSON BROS.

[The above caution applies to almost all tools made from old files. The temper should always be drawn before they are used, if subject to hammering, like a center-punch, chisel or other percussive tools, and preferably for any purpose, on account of the brittleness of the tool if left "file hard."—EDITOR.]

FINISHING PISTONS AND PISTON RINGS ON THE GISHOLT TURRET LATHE.

The making of pistons and piston rings for gas engines, particularly for automobiles, is done on so large a scale that the expenditure of considerable thought and time is warranted in designing the tools, fixtures and machines by which the work is done. Figs. 1 and 2 show the operations developed by the Gisholt Machine Co. of Madison, Wis., for doing this work in its turret lathe. As will be seen from the engravings and the following description, the tools used are simple and inexpensive, and the operations comparatively few.

As is often advisable with work done in large quantities, the rough castings are made with extra projections so arranged as to assist in holding the work, these extraneous parts being removed when the piece is completed. In the case shown (Fig. 1), a ring, about 1¼ inch long and of a diameter a trifle less than that of the piston itself, is formed at the head end of the piston. The piston *A* is held in suitable chuck jaws *B* by the inner diameter of this ring. The set-screws in these special jaws are then set down on the work, clamping it tightly between the points of the screws and the jaws, in such a way as to make it safe to take heavy cuts on the outer end of the long piston without loosening it. It will be seen that this method of holding, besides being secure, also permits the whole exterior of the piston to be turned, since all of it projects beyond the chuck jaws. This is the object aimed at in providing the piston with the ring by which it is held.

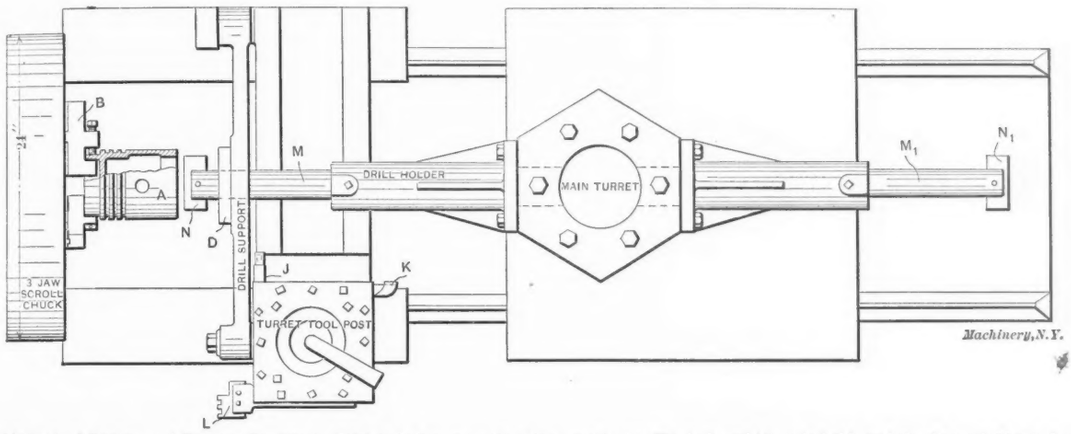


Fig. 1. Method of Boring and Turning Pistons in Gisholt Lathe; note the Ring cast to the Work, by which it is held, and the Special Chuck Jaws used.

The first operation, which is shown in action in Fig. 1, consists in rough-boring the front end of the piston. The double-ended cutter *N* is held in boring-bar *M*, which is in turn supported by a drill holder, clamped to one of the faces of the turret. This bar is supported in a bushing in the drill support shown, which is attached to the carriage, and may be swung into or out of operating position as required. After this cut is completed, the turret is revolved half way around and the piece is finish-bored in a similar manner, with double-ended cutter N_1 held in bar M_1, the drill support being used as in the previous case. The support is then turned back out of the way to allow the turning tools in the turret tool-post to come into action.

The outside diameter of the piston is next rough-turned with tool *K* in the turret tool-post, which is revolved to bring this cutter into action. The post is then turned to the position shown, in which the outside diameter of the work is finish-turned by tool *J*, which takes a broad shaving cut. The turret tool-holder is again revolved to bring form tool *L* into position for action. This cuts the grooves in which the piston rings are to be located. Suitable positive stops are, of course, provided for both the longitudinal and cross movements of the turret tool-post.

In the second operation, the work *A* is reversed and held in soft jaws, which are used in place of the hardened jaws *B* shown in the illustration. These jaws are bored to the outside diameter of piston *A*, so that when closed, they hold the work truly with the first chucking. In this operation, the chucking ring by which the piston is previously held is cut off, and the end of the piston is faced. If the crank-pin hole is to be finished, still a third operation is necessary, a self centering chuck-plate and the necessary boring tools being used for this. These are not here shown, however.

The method of making piston rings is shown in Fig. 2. In this case, as in the previous one, the casting is one having a special form to facilitate holding it in the turret lathe. The piston rings are cut from a cast iron cylindrical piece which has three lugs (seen at *B* in Fig. 2) cast on one end and so arranged that they may be held by these in a three-jawed scroll chuck. This cylindrical piece is about 10 inches long, and when the rings are to have their inside and outside surfaces concentric, the casting is held by them in the regular jaws furnished with the chuck. The arrangement used for eccentric turning and boring, which is that shown in the illustration, will be described later.

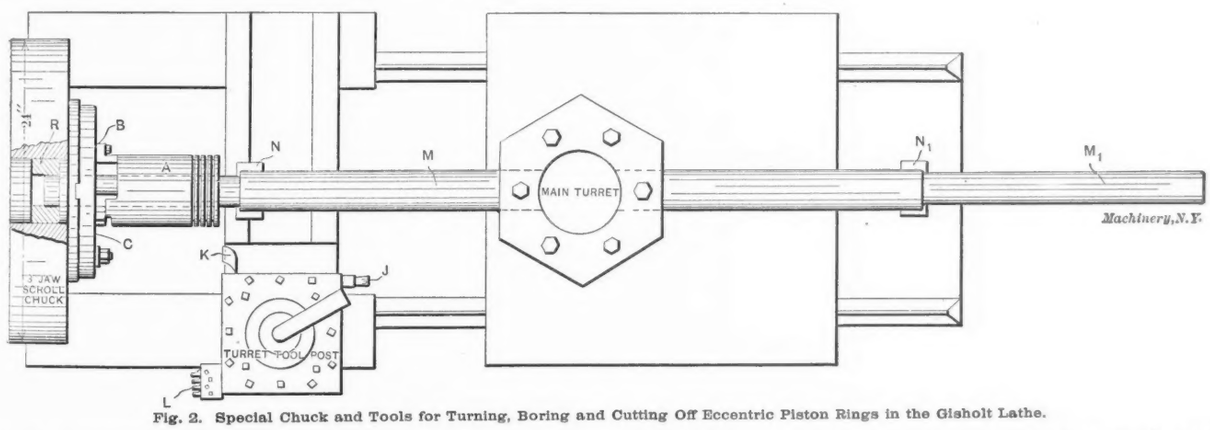


Fig. 2. Special Chuck and Tools for Turning, Boring and Cutting Off Eccentric Piston Rings in the Gisholt Lathe.

The casting *A*, from which the rings are made, is first rough-bored with double-ended cutter *N* in boring-bar *M*, after which it is finish-bored with cutter N_1 in bar M_1. While taking these cuts, the bars *M* and M_1 are supported by their for-

ward extension in bushing *R*, located in the central hole of the chuck. This furnishes a rigid support for the cutter, so that a heavy chip can be taken.

The periphery of the piece is next rough-turned with tool *K*, held in the turret tool-post. This tool-post is then revolved to bring tool *J* into action, by which the outside of the work is turned true to size, a broad shaving chip being taken. The turret tool-post is again swung around, to bring the cutting-off tool-holder *L* into use. This, as shown, contains four blades set the proper distance apart to give rings of the desired width. Each blade is also set a little ahead of the preceding one, so that the rings are cut off one after the other, each ring supporting the cut being taken on the outer side of it, until that cut is completed. After the first four rings are cut off, the carriage is moved ahead again to a second stop, and four more rings are severed, the operation being continued until the casting *A* has been entirely worked up into rings.

When the bore of the ring is to be eccentric with the periphery, the holding arrangement shown in the cut is used. The casting *A* is bolted to a sliding chuck-plate *C*, and the periphery is rough turned with tool *K* in the tool-post. Finishing tool *J* is then brought into action, and the outside diameter is turned accurately to size. Then the sliding chuck-plate *C*, carrying the work, is moved over a distance equal to the eccentricity desired, and the work is rough bored with cutters *N* and N_1 as in the previous case. The turret tool-post is next revolved and the cutters *L* brought into play, when the rings are cut off, as before. The reason for finishing the periphery first in this case is apparent. To secure good clean work in cutting off, this operation should evidently be done when the work is running concentric with the bore, rather than with the exterior surface.

It will be evident that this method gives a far greater out put of rings than is possible by finishing them in the more primitive way on engine lathes. The faces of the rings may be finished in a second operation if desired, or they may be ground, depending on the method in vogue in the shop where the work is being done.

* * *

SHOP ELEVATORS, AND OTHER THINGS.

CON WISE.

A few months ago I went into two shops in the same city. At the first one I found a sign at the door "Blank Mfg. Co. upstairs." At the top of the first flight I found another just like it and so on till at the top of the fourth I read the welcome one, "Blank Mfg. Co., one flight up." Needless to say the discounts that I had planned to offer grew less at each sign, and if I had been buying instead of selling, I would have given up the climb altogether. When I arrived, I tried to get a chance to look around the factory. I was not refused, but it was painfully evident that it was an unusual thing for them to see a visitor in the works. The workmen acted as if we were a lot of wild animals on exhibition, and it was almost impossible to pick our way around among the piles of work and rubbish.

At the second shop I asked at the office downstairs for permission to look around, and was promptly given a pass card, shown the shop door and told that I would probably meet one of the proprietors somewhere. I found it a rambling place full of odd corners and turns, but I wandered around rather aimlessly for an hour without a question or look of inquiry from anyone. After a time I saw two men in overalls get off an elevator. The sight was so odd that I sauntered over and asked the boy who engineered the thing—where he went to when he went down. "The engine room," he said. "Nice plant there; don't you want to see it?" Needless to say I did. Another man in overalls got on too. I looked at my pass to see if there was anything about talking to the help, and then asked him how it happened that they were allowed to ride on the elevator, and how they liked it. "It's all very nice,'" he said, "but it is all the same to us whether we ride or not. If we ride and save any time we have to get out enough more work to make up. They don't let you blow your nose but just so many times a day here, and they calculate to get us just so tired at night. It pays them all right, but we don't ask about elevators when we are out looking for jobs."

I could not help comparing the two places, and then inquiring about both. It turned out that in the first shop they never expect to see a customer from one year's end to another. They go out to buy their stock themselves and they can carry a full line of samples in an overcoat pocket. They are not bothered by agents or solicitors to see their help. They pay their workmen by the piece and never have any trouble getting all the help they want. They are making money, and the proprietor thinks that if he can stand the stairs, no one else has a right to complain.

In the other shop they seldom sell to a new customer who does not come and look them over. Consequently they are always on exhibition. They are accustomed to visitors and they know that it will not do to walk a silk-hatted, short-winded customer up and down stairs long enough to see the plant; hence the elevator. The elevator being there, why not make it pay dividends? Man power costs more than steam power every time, so why not let the men ride and then get enough more work out of them to make it pay? It is fine advertising to show the silk-hatted fraternity what philanthropic citizens they are and how thoughtful of the welfare of their humble brethren. And it takes all right because the "silk-hat" never thinks of approaching a workman from a point of view that gives him a chance to feel that he can talk freely.

These chaps in the shops care precious little about but two things. One is, how much money they can carry home pay night as compared with the time they spend away from their wives and children to get it, and the other is whether their work is congenial.

This latter does not have as much to do with flower gardens and ambulance corps or any such things, nor does it have much to do with labor-saving devices which are only used to save the employer on his production cost. It does have a great deal to do with means of lightening the actual brute strength required from an operative in a day, and a great deal more with the decency with which the foremen treat the help. A great many foremen do not know that it is possible and profitable for them to be gentlemen and yet get the work out, and a great many employers do not realize that it pays to get gentlemanly foremen, nor that such foremen attract the best help.

The average employe understands perfectly that he has no legal right to share in the profits brought about by another man's brain work, but he cannot see why all men are not as brotherly toward him as he is toward his neighbor on the next lathe. Did you ever see a rich man that would do as much for famine sufferers or neighbors in distress as a $15-a-week machinist will, in proportion to his means?

A man in the shop cannot see and cannot be made to see, and I am glad of it, why a man, as soon as he gets more money than he needs for his own daily use should not look around for some one in need to help a little; not to insult him with money, or to patronize him, but to help him carry his burden easily.

Now all this does not mean that I nor the men in the shops do not believe in the uplifting influences of all the flower gardens or pleasant homes, nor that we are looking for the dollar to the exclusion of everything else. Not at all! What we would like would be to feel that all these uplifts were ours, that if we wanted to lie down on the grass we could do so, and that we could have a feeling of proprietorship in the cosy cottages that are held out to us as inducements to move. But in almost every case we find that these things have strings on them, and even when we feel that we are paying for all the extras, we find that they are liable to be yanked back if anyone in authority gets a bit on his ear at us. In a word, independence was worth fighting for years ago, and it is worth something now.

* * *

The spring convention of the National Machine Tool Builders' Association will be held at Atlantic City, N. J., Tuesday and Wednesday, May 19 and 20, with headquarters at the Hotel Chalfonte.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

SELECTING CUTTER FOR FLUTING CONCAVE MILL.

M. E. M.—The accompanying cut (Fig. 1) shows a milling cutter having a concave surface, and it is required to find an angular milling cutter for milling the teeth in this concave mill so that the width of the land y will be the same both at the center and at the outside edges of the mill. The problem may be stated thus: If the number of teeth, the width and diameter of the mill, and the radius of its concavity are given, to find a cutter which will mill the teeth so that the width of land y remains constant for the full width of the mill.

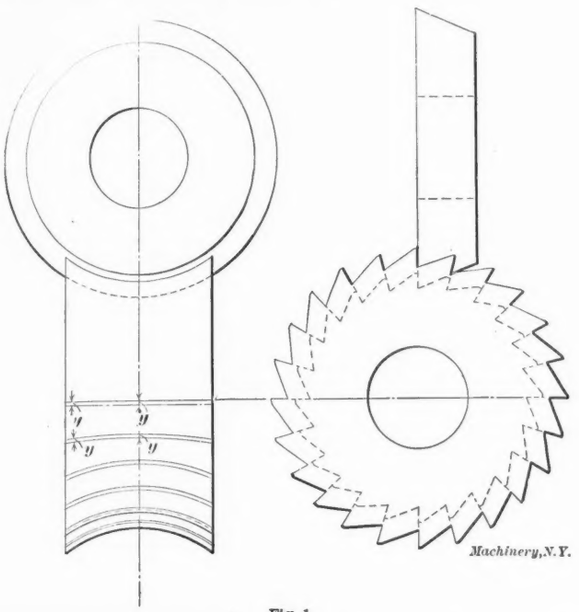


Fig. 1.

A.—Theoretically, this problem is one the conditions of which do not permit of a solution. Suppose, for instance, that the width of the land of the teeth be infinitesimal; this will make it easier to state the case in a clear manner. In Fig. 2, the cutter surface of the cutter for milling the teeth, being that of a cone, is represented by $A\,B\,C$, the cutter being imagined as extending out to a sharp point at the apex C of the cone. The mill to be provided with teeth is represented by the half-circles $K\,L$ and $M\,N$, the latter being the line at the bottom of the circular groove at the center. Assume that $D\,E$ is the pitch of the mill at its largest circumference. Then, a plane $O\,H$ passed through the point E from the center of the mill produces a circular arc $E\,F\,E$ where it intersects with the surface of the blank of the mill. The section produced by this plane in cone $A\,B\,C$, however, is an ellipse. As a circular arc and an ellipse never can fully coincide, it is evident that the problem contains conditions which make it impossible. If, however, the pitch $D\,E$ is very small in proportion to the radius $O\,E$ of the mill, so that the section $F\,G$ of the cone nearly resembles a circle, then a cutter may be determined that will cut the teeth to agree *approximately* with the conditions given. What is then necessary is that the diameter of the cone, or angular cutter, at point F shall be as nearly equal to the diameter of the circle forming the outline of the mill blank as possible.

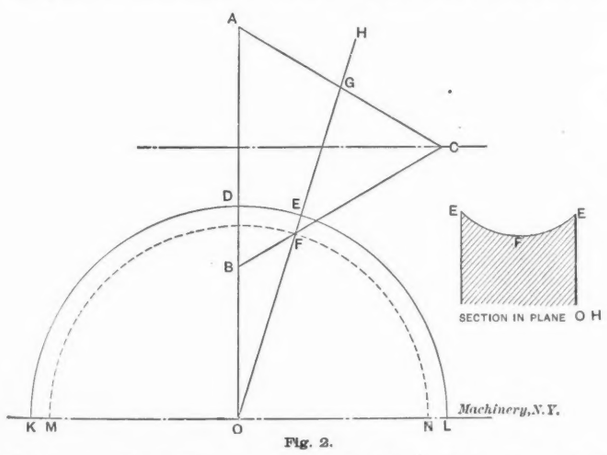


Fig. 2.

In practice the problem is usually solved by the cut and try method, approximate results only being obtained. Approximate formulas no doubt could also be worked out, and if some of the readers of MACHINERY who meet with this class of work have adopted any special rules which they follow, we would be pleased to place them on record.

TO OBTAIN FACE ANGLE OF BEVEL GEARS.

E. H.—Please tell me how to obtain the face angle, measured as shown in Fig. 1, for two bevel gears, 25 and 50 teeth, 10 diametral pitch. The shafts are at right angles.

A.—To find the face angle for a pair of bevel gears, proceed as follows, using the reference letters below in addition to those shown in Fig. 2.

N = number of teeth in gear;

n = number of teeth in pinion;

ϵ = face angle, as usually measured.

First we get the pitch cone angle of the gear

$$\tan \beta = \frac{N}{n} = \frac{50}{25} = 2.000 = \tan 63^\circ\ 26', \qquad (1)$$

then we obtain the addendum angle

$$\tan \delta = \frac{2 \times \sin \beta}{N} = \frac{2 \times 0.89441}{50} = 0.03578 = \tan 2^\circ\ 3' \qquad (2)$$

Adding together (1) and (2), we get

$$\epsilon = \beta + \delta = 63^\circ\ 26' + 2^\circ\ 3' = 65^\circ\ 29'$$

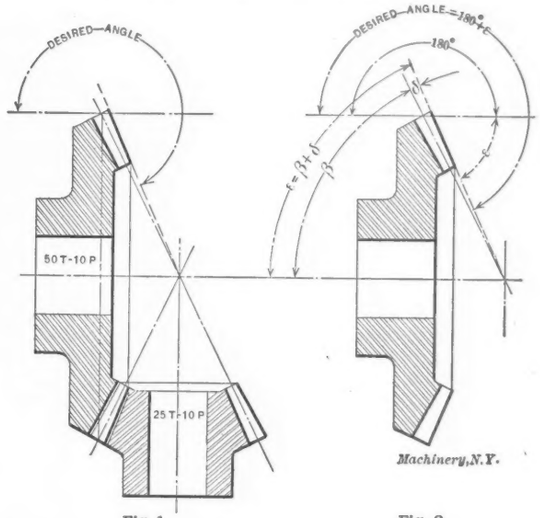


Fig. 1.

Fig. 2.

The face angle is usually measured as shown in Fig. 2; the angle you call for is 180 degrees more than this.

$$\text{The desired angle} = 180^\circ + 65^\circ\ 29' = 245^\circ\ 29'$$

The pitch cone angle of the pinion is found thus:

$$\beta_p = 90 - \beta = 90 - 63^\circ\ 26' = 26^\circ\ 34'$$

The angle as usually measured will then be

$$\epsilon_p = \beta_p + \delta = 26^\circ\ 34' + 2^\circ\ 3' = 28^\circ\ 37'$$

So that for the pinion we have

$$\text{The desired angle} = 180^\circ + 28^\circ\ 37' = 208^\circ\ 37'$$

Rules and formulas for obtaining the various measurements of miter and bevel gears of various kinds will be found in the data sheet published with the May, 1907, issue of MACHINERY.

* * *

A speed of 44 statute miles, or 38.3 knots per hour, was attained over a mile course last December by the British torpedo boat, *Tartar*. This is the highest speed that has ever been attained by a craft of this class.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

WOODS ENGINEERING CO.'S UNIVERSAL TOOL AND CUTTER GRINDER.

In Figs. 1 to 6 we show, performing various operations, a tool and cutter grinder built by the Woods Engineering Co., Alliance, Ohio. The machine is the result of long experience with tools of this class, and it comprises a number of useful features not found in other designs.

As may be seen, the grinding head is mounted on a stationary column rising from a broad, stiff base which is bolted to the floor. The upper part of this column is turned to a smaller diameter, and has fitting over it a sleeve which can be set at any angle throughout the full circle. This sleeve supports the knee on which the work table is carried. Clamping the sleeve to set the work table at the proper angle with relation to the wheel, does not interfere at all with the vertical adjustment of the knee on the sleeve, the movements being independent. The two bolts on the lower flange of the sleeve are used for clamping it at the desired angular adjustment. The emery wheel spindle has two speeds, is made of

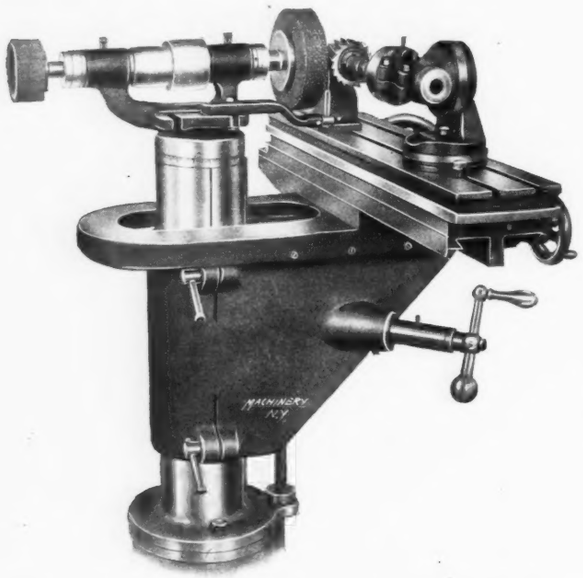


Fig. 1. The Woods Cutter and Reamer Grinder, sharpening a Spiral Mill.

tool steel, ground to size, and runs in phosphor bronze bearings which are adjustable for wear, and are as nearly dust proof as it is possible to make them.

A saddle is adjustable in and out on the knee, and the work table has a horizontal movement on the saddle, the arrangement being about the same as in the orthodox type of milling machine. These three adjustments, the vertical, cross and longitudinal, are obtained by hand-wheels and a crank which are so set as to be within convenient reach of the operator, and yet not interfere with each other in any position. The connections for the cross and vertical feeds are obvious. For the longitudinal feed of the table, the hand-wheel shaft is provided with a spiral pinion, meshing with a rack fast to the under side of the table. The bearing surfaces on which these various sliding movements take place are all carefully protected from emery. The protection for the bearing of the saddle on the knee is best seen in Figs. 1, 2, and 4. It consists of the guard which practically forms a part of the saddle and encircles the column at the rear, covering the surfaces at all times, no matter what the setting of the parts. The sides of the table are brought down below the bearings by which it is gibbed to the slide, so that these are also protected. The guards may be seen in the end views Figs. 1, 2, and 4. The slides all have 45-degree bearing surfaces. Both elevating and cross-feed screws are provided with micrometer dials reading to 0.001 inch.

The other structural features of the machine can perhaps best be understood by referring to the operations shown in progress in Figs. 1 to 6. In Fig. 1 a spiral mill is being ground. This is mounted on an arbor between the head and foot-stock centers as shown. The tooth being ground by the

Fig. 2. Sharpening a Face Mill, whose Shank is held in a Universal Taper Holder.

cup wheel rests on a tooth support immediately beneath the grinding point. As the cutter is moved back and forth by the hand-wheel, the face of the spiral cutter is kept pressed on the tooth rest so that it is properly presented to the wheel. The tooth rest, it will be noted in this case, is clamped to a shelf at the side of the grinding head. It will be seen that

Fig. 3. The Machine arranged for Plain Cylindrical Grinding on Dead Centers.

the head-stock has a universal swiveling adjustment. This comes into play in grinding angular mills of all kinds, these being generally held on taper shanks or arbors pressed into the taper hole of the head-stock spindle. This spindle runs in dust-proof bronze bearings, and is adjustable for wear.

In Fig. 2 a universal taper holder is shown in place, clamped to the head-stock swivel, from which the spindle head has been removed. This attachment is adapted to holding taper and cylindrical shanks of larger size than can be held in the taper of the regular spindle. The face mill shown is having its teeth ground on the face, the tooth rest being in this case fastened to the table. Stops are provided for limiting the traverse of the table. These are plainly shown in this view. They consist of collars which are clamped to the rod shown extending along the front of the table. They engage a stop piece fast to the knee, which may be thrown up between them, or dropped out of the way if it is desired to run the carriage beyond the stop. Another view of this arrangement may be had in the next figure.

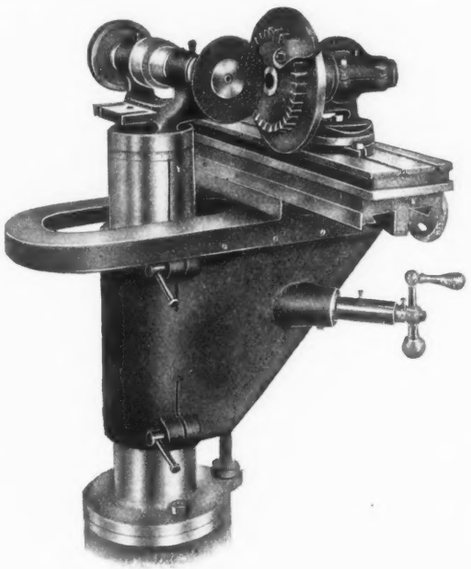


Fig. 4. Grinding the Hub of a Cutter on the Face-plate.

Fig. 3 shows the machine as arranged for plain cylindrical grinding. A center, carrying a loose pulley whose flange forms the driving face-plate, has been inserted in the taper hole of the head-stock. The spindle of the head-stock, to which the rear pulley is keyed, is locked by a plunger as shown, having a point entering holes in the rear flange of the driving pulley. When the spindle is thus locked, the work revolves on dead centers, as is usual in cylindrical grinding. The locking plunger and the holes in the pulley flange also serve as an indexing device for use when grinding broaches, punches, etc., in square, hexagonal and other shapes.

Fig. 5. Truing a Large Center, with the Table swiveled for the Angle.

The tail-stock spindle has a spring center, to take care of the expansion of the work due to heating; the center may be locked, however, for work which requires it. It will be noted in comparing Figs. 2 and 3 that the knee and table have been swung around 90 degrees between the two operations.

In Fig. 4 is shown a face grinding operation. A hardened cutter is mounted on a face-plate attached to the head-stock spindle, which is revolved by a belt from the counter-shaft. The work is traversed across the wheel by the regular table feed, and is fed in to depth by the cross slide nand-wheel in an obvious manner.

The top of the work table is pivoted, as shown in Fig. 5, to permit the grinding of tapers on centers, or in the follow rest as in this case. For comparatively small tapers this adjustment may be obtained very accurately by means of the screw and nut arrangement shown at the end of the table. This is disconnected in Fig. 5, the upper half of the platen being swung at a much greater angle than that connection allows. To clamp the platen to the table under these circumstances, two dogs are provided, as shown, one on each side. The large lathe center being ground is held at one end in a chuck which is part of the equipment provided, while the other end is held by the regular center rest furnished with the machine.

Fig. 6 shows the internal grinding attachment. This is mounted in a frame which is bolted to a shelf at the side of the grinding head. The hardened cutter on the face-plate is having its central hole ground to size. The internal grinding spindle is speeded up from the main spindle as shown, the ratio between the two pulleys being sufficient to give a suitable velocity for internal grinding. The spindle has a bearing next to the emery wheel, thus doing away with vibration due to long over-hang.

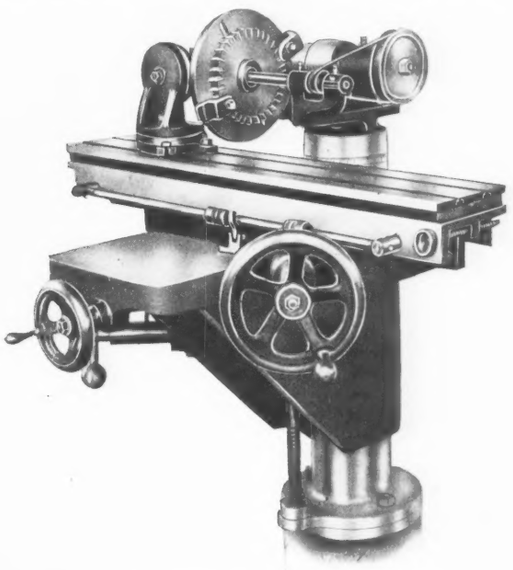


Fig. 6. The Internal Grinding Attachment in Use.

Other uses for this machine can readily be imagined from inspecting the examples we have shown here. For instance, the tool is well adapted to surface grinding. For this purpose, a universal swivel chuck is provided, which can be adjusted to any angle in three different planes, so that angular work of any conceivable shape can be ground true. When so working, the table is swung around so that its travel is at right angles with the axis of the grinding spindle. The changes from one operation to another can be made easily and rapidly, owing to the convenience of the various adjustments. The emery wheel spindle has two speeds, is made of tool steel ground to size, and runs in phosphor bronze bearings, adjustable for wear, and as nearly dust-proof as it is possible to make them.

The longitudinal travel of the machine is 22 inches, the cross feed 7½ inches, and the vertical adjustment 9 inches. It will take 22 inches between centers, and swings 9 inches

over the table. Various wrenches, dogs, tooth rests, and attachments are provided, as well as wheels suitable for the work of the machine. The weight without the counter-shaft is about 700 pounds.

LIBBY TURRET LATHE.

The turret lathe illustrated in the three accompanying half-tones is built by the International Machine Tool Co., of Indianapolis, Indiana. It is the design of Mr. Chas. L. Libby, who has had extended experience in work of this kind in both this country and Europe. It is intended for the general run of chucking and turning work for cast iron and steel parts up to 20 inches in diameter.

Spindle Driving Mechanism.

An inspection of Fig. 1 will show that the machine is built in the heavy, rigid style necessary for the effective use of modern high speed steels. The head-stock and bed are cast

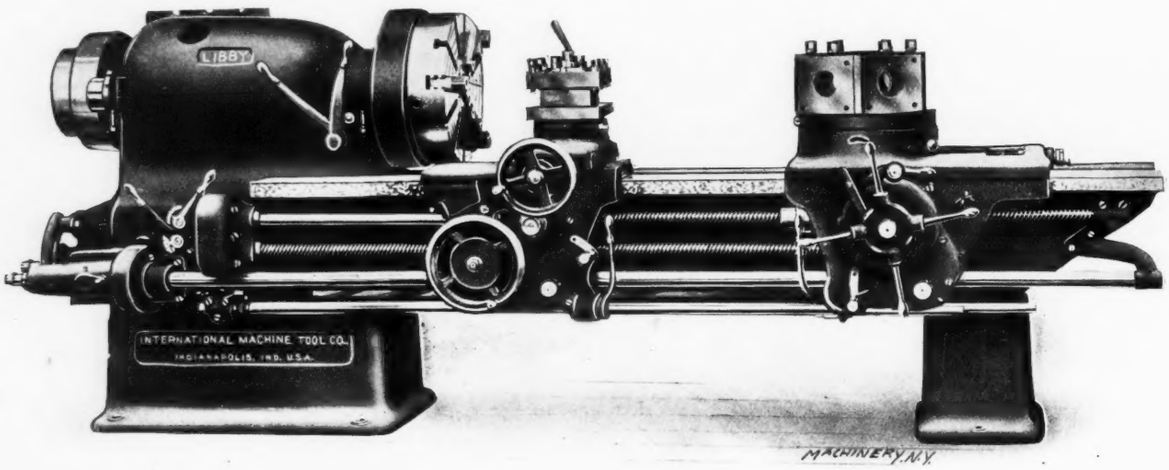


Fig 1. Libby Turret Lathe, made by the International Machine Tool Co., Indianapolis, Ind.

in one piece, and the bed is unusually deep and rigid. The spindle is of large diameter, with journals suitably proportioned, and with a 3⅝-inch hole through its center. It is driven from the two-step cone pulley shown at the outer end of the head-stock, through a mechanical speed changing mechanism enclosed within the head-stock and operated by the two levers at the front of the main bearing. These levers give four changes of feed, which are multiplied by the two obtained from the driving pulley, and these in turn by the three obtained from the three-speed counter-shaft, giving 24 changes in all. The speeds vary in geometrical progression from 5 to 180 revolutions per minute.

One of the features to which attention is called is the provision made for changing the machine from belt to motor drive independent of the builder. This can readily be done without having to rearrange the head-stock for each type of motor, thus avoiding delay and extra expense. Any motor having a speed range of at least 2 to 1 can be used. It may be mounted on the finished pads provided on the head of the machine, and connected with the driving shaft by gearing, or it may be mounted on the floor and belted to the machinery. It will be seen that the change can be made at a very low cost.

Tool-post and Turret Slides.

The tool-post carriage is of unusual construction. It does not extend across the bed, but is supported by the front way and by a V-guide at the bottom of its apron, bearing on a corresponding way on the lower edge of the bed. A long taper gib fitted to the carriage on the inside of the bed takes up the wear. As shown in Fig. 2, the tool-post carriage may be moved past the chuck toward the head-stock. This permits the use of the turret close up to the chuck, avoiding the overhanging tools usually required to reach over the tool-post cross slide. It is evident, also, that nearly the full capacity of the lathe can be swung over the carriage.

The six-sided turret is supported on a spring pivot bearing which is adjustable to its load, and takes the weight of the turret and tools off the annular bearings, thereby reducing the friction and the wear, and permitting it to be indexed easily. The clamping device acts at the outer edge of the turret, bringing it down firmly to the annular bearings after the indexing has taken place. The same lever that tightens and releases the turret clamp operates the turret locking pin. Throwing the lever in one direction releases the clamp and withdraws the locking pin. The turret may then be swung to the desired position. By throwing the same lever a little further over, the locking pin is released and the turret located. By again bringing the lever back to its original position, the turret is once more rigidly clamped.

Feed Mechanism.

The feed motion is operated from the spindle through change gearing and a quick change apparatus. Eight changes may be obtained by operating the two levers shown beneath the head-stock, and eight changes more are regularly provided for with the detachable gears furnished with the machine. Either English or metric threads can be cut without changing the screws. The feeds and screw threads obtainable vary from 1 to 200 revolutions of spindle per inch of slide movement.

The feed connections for the tool-post carriage and turret slide are entirely separate, so that the feed of either apron

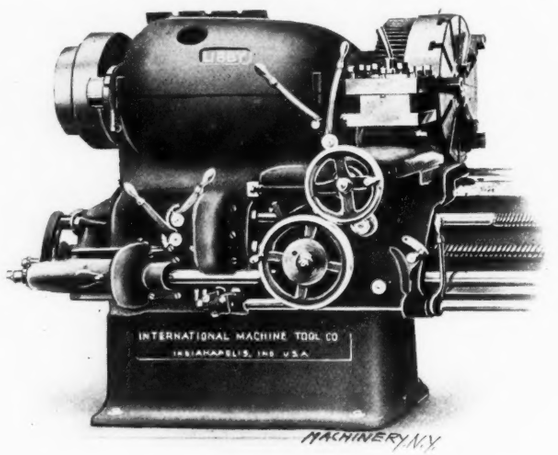


Fig. 2. The Tool-post Carriage brought close to the Head-stock, showing how it clears the Chuck.

can be reversed without interfering with the other. Both carriages may be shifted independently by quick traversing devices. This movement can be operated at any time by the action of a single lever, the setting of the feed not interfering with this. The rate of movement of the quick traverse is about 25 feet per minute. The screw cutting and power feeds are applied to both carriages. In the tool-post carriage

the cross and traverse feed screws have the same lead. All the handles for operating the various changes, both of the speeds and feeds, are within easy reach of the operator, as he stands in working position. All the moving parts, as may be seen, are encased to prevent injury to the mechanism or the operator.

Automatic stops are provided for feeds in all directions. In connection with these stops, there is an indicator or moving pointer which registers the exact position of the turret cutting tools. This can readily be seen by the operator, and makes possible the attainment of duplication of work to a degree of exactness that would otherwise be difficult. The gearing of the turret apron is so arranged that one revolution of the pilot wheel gives only ½ inch of movement to the

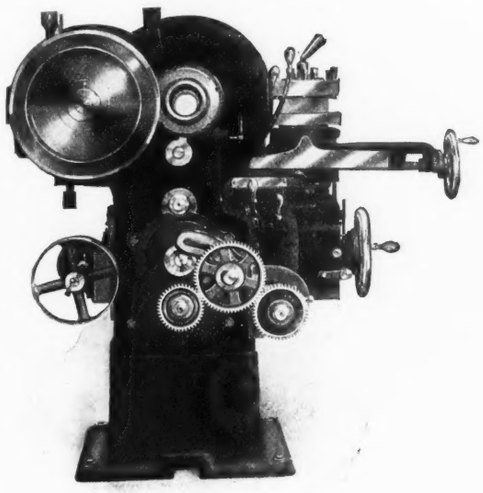


Fig. 3. End View of the Libby Turret Lathe.

slide. With this ratio, the operator has sufficient leverage to bring the tool up to a heavy facing cut without exerting himself unduly.

Method of Operation.

The makers are prepared to design and construct special tools for doing work to the best advantage. The ordinary method of procedure may be described as follows: The rough casting is grasped in the hard steel jaws of the chuck, where it is bored and reamed. Then a bushing, which fits the supporting arbors used with the facing heads on the turret, is inserted into the hole just made. The facing heads, which are made to carry a variety of tools, are next run up to the work, which is shaped to the dimensions required. In most cases two facing heads are used, one for roughing and one for finishing. Owing to the fact that the reaction of the cutting strain is taken directly in the work itself, there is very little deflection of the tools under the pressure of the cut, and heavy chips can be taken.

If a second chucking is required to finish the part complete, the hard jaws are removed and a pair of soft jaws substituted. These are set down to a little less than the size of the piece to be held, and are bored out to the exact size of the work, so that when this is again clamped in the chuck the jaws are in the same position as when being bored, and the work runs truly if the first operation is carefully done. This procedure applies to the general run of cast iron work.

The arrangement for supporting the drill or boring-bar is different in this type of machine from that ordinarily used. The support is located at the back of the machine, and is entirely independent of the carriage, so that while it is being used to guide the drill or boring-bar, the carriage can be used for turning. This often makes considerable difference in the output of a machine of this kind.

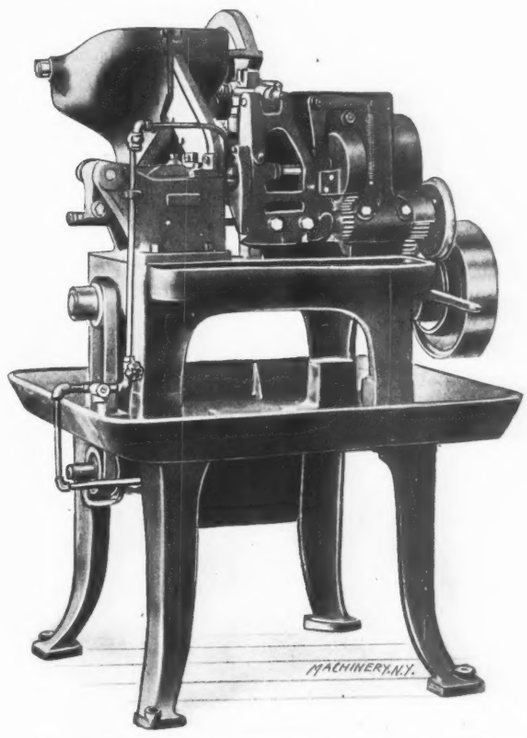
The machine is evidently suited for finishing on the interchangeable plan such parts as gear blanks, small fly-wheels, automobile cylinders and parts, couplings, rope drums and other similar work within its capacity. It will swing 22 inches over the ways, and 20 inches over the carriage. The traverse of the turret slide is 60 inches, and the hole through the spindle is 3⅝ inches in diameter. The turret holes are 3½ inches in diameter. The 2-step cone pulley has faces of the proper width for a 3¾-inch belt. The machine will be furnished with oil pan and pump, when desired, for steel work. It is 12 feet 8 inches long over all, and has a shipping weight of about 9,000 pounds.

WATERBURY-FARRELL AUTOMATIC SCREW SLOTTING MACHINE

The tool shown in the accompanying engraving, built by the Waterbury-Farrell Foundry and Machine Co., Waterbury, Conn., is an improved automatic slotting machine for work on screw blanks for filister-head screws, stove bolts and other similar products. The experiment and study spent in the designing of this machine were directed toward obtaining accurate work at rapid rate of production, special attention being paid to rigidity, with the corresponding increase of output possible for a slotter.

A hopper feed is used, which automatically presents the blanks, as they are required, to a toggle carrier slide, which brings them into position in front of the saw. Here each blank is gripped securely between a die and a carrier slide, for the slotting operation. The saw spindle is mounted on a swinging bracket, which is well braced and guided to prevent chattering. The saw is swung on this in cutting the slot. To cut off the burr which forms on the head when the saw is dull, a chip shaver is furnished. This is a small cutting tool which passes over the head of the blank as the saw returns, and smooths off the burrs.

The machine is driven by a friction clutch pulley, through change gears which give a wide variation in the number of blanks that can be slotted per minute, thus making it suitable for varying sizes and kinds of screws.



Automatic Hopper-fed Machine for Slotting Screw Blanks.

An oil pump is provided to give a uniform flow of oil over the work, and suitable guards are furnished to keep the saw and dies clear of dirt, chips and other foreign matter. A pan under the machine collects the lubricant, strains it from the chips, and returns it to the tank and the pump. When desired, the machines can be mounted in groups, instead of on single bases as shown. When this is done, a long table is used, which also forms a drip pan, all the machines in the group being driven from a single pulley.

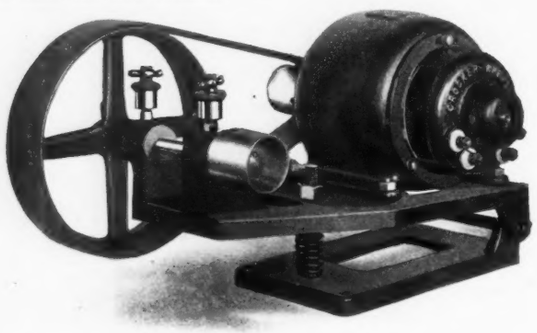
The machine shown will take screws from 3/16 to ¾ inch in diameter up to 2½ inches long. It will operate on

thirty-five 3/16-inch blanks per minute, the saw used being 2¾ inches in diameter. This capacity may be exceeded on shallow slots and brass screws. For a single machine, the floor space occupied is about 44 x 41 inches, and the weight of the machine is 1,240 pounds. The floor space occupied by a group of six machines is 44 inches by 19 feet 10 inches, and the weight of the six machines is 7,540 pounds.

COUNTER-SHAFT BELT TIGHTENER FOR USE WITH CROCKER-WHEELER MOTORS.

We show herewith an arrangement of motor and self-contained counter-shaft which is being installed by the Crocker-Wheeler Co., of Ampere, N. J., for driving light machinery. Though designed primarily for driving the linotype, it can be used to advantage with other machinery requiring a slow speed drive.

A cast iron sub-base is used, provided with lugs to which is pivoted the cast iron base on which the motor and counter-shaft are mounted. Tension between the pulley on the armature shaft of the motor and that on the counter-shaft, is maintained by the usual plan of shifting the motor on the base, with the aid of an adjusting screw. For the belt connection between the small pulley of the counter-shaft and the driving pulley of the machine, the tension is regulated by an adjusting nut bearing on the pivoted base, which forces the front end of the latter downward, thus increasing the center distance of the pulleys over which the belt runs. A spring is provided at the front end to support the tilting base in case the belt breaks.



Motor mounted on Base Plate with Self-contained Counter-shaft.

As compared with the ordinary idler, the use of this intermediate counter-shaft avoids the usual great difference between the size of the driving and driven pulleys, so that the belts make better arcs of contact with the pulleys, resulting in a consequent decrease of slippage. The motor shown is the "L-type," made by the builders in sizes from 1-20 to 5 horse-power. It has a neat appearance and is compact in design, being especially suited for direct connection with small tools, printing presses, pumps and other light machinery. By applying covers for the openings in the frame, the motor can easily be made dust and moisture proof, for service where the open type would be out of the question.

INGERSOLL HORIZONTAL MILLING MACHINE WITH SUPPLEMENTARY VERTICAL SPINDLES.

In Figs. 1 and 2 are shown front and rear views, respectively, of a horizontal milling machine whose cross rail has been arranged to support a pair of vertical spindles, to be used in conjunction with the horizontal spindle of one of the regular line of horizontal spindle, planer pattern millers, made by the Ingersoll Milling Machine Co., of Rockford, Ill.

The vertical spindles, as may be seen in Fig. 2, can be adjusted to any position between the housings, by means of the rack and pinion arrangement with which they are provided. The spindles also have independent vertical adjustments. They are driven by spiral gearing, encased to run in grease, from a horizontal shaft which extends along the cross rail, and is connected by spur gearing with the main spindle of the machine. Cutters up to 8 inches in diameter may be used on the vertical spindle, there being no interference in any way with the action of the horizontal cutter.

This arrangement is useful in milling work in which vertical and horizontal cuts have to be taken that would otherwise require the use of expensive gang cutters, but which, in this way, can be done with stock tools. It is also possible to machine surfaces at one cut that would be impossible to do even with gang tools, such as finishing horizontal surfaces and cutting tongues or grooves in the sides of vertical surfaces, at the same operation.

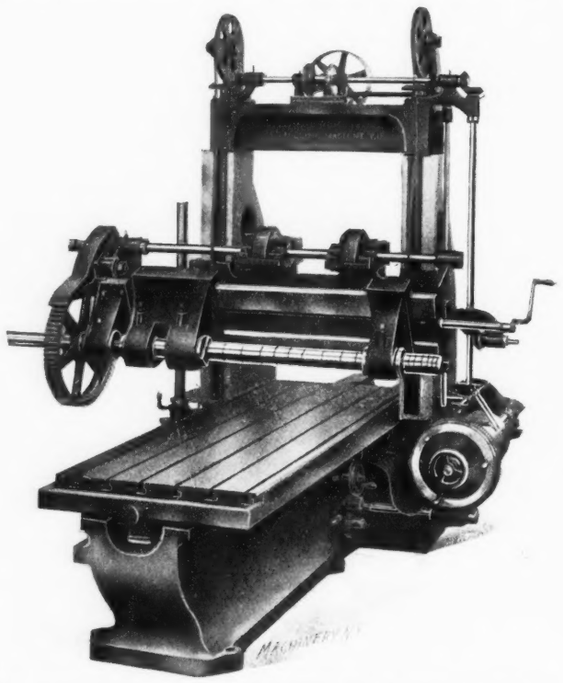


Fig. 1. Ingersoll Horizontal Milling Machine, with Supplementary Vertical Spindles on Back of Cross Rail.

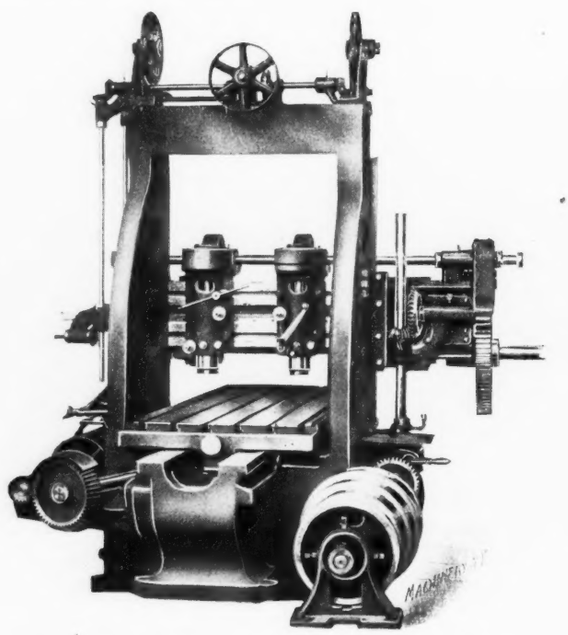
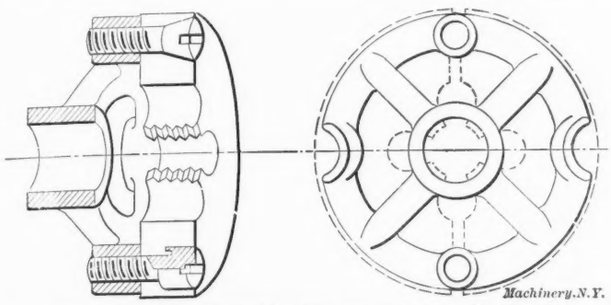


Fig. 2. Rear View showing Arrangement of Vertical Spindles

This method of attaching spindles at the back of a cross rail is not confined entirely to horizontal milling machines, like that shown in Figs. 1 and 2. The arrangement may be used with any other machine which has a cross rail, the builders having furnished vertical machines of this type with four heads on a single rail, two at the front and two at the back. This makes it possible to take cuts closer together than would be the case if all the heads were on a single rail.

GREEN RIVER SCREW PLATE FOR BRAZED BRASS TUBING.

The accompanying line cut shows a Green River die with an improved guide, designed for threading brazed brass tubing. The die used is the standard form furnished with the maker's ordinary sets for threading bolts and nuts. Particular attention is called to the long bearing provided by the style of



Green River Dies with Bushing Attachment for Threading Brazed Brass Tubing.

guide used, thus enabling the operator to always be sure of cutting straight and perfect threads. The dies are so formed as to leave a large space for getting rid of chips, and give also an excellent opportunity for oiling the work.

The device is furnished in all sizes, from 3-16 to 1 inch in diameter, the usual pitch being 27 threads to the inch for all American sizes, and 26 threads to the inch for all English sizes. These screw plates are made by the Wiley & Russell Mfg. Co., Greenfield, Mass.

FRONT CROSS FEED FOR GOULD & EBERHARDT SHAPERS.

The device, whose absence is indicated by the position of the operator in Fig. 1, and which is shown in use in Fig. 3, is not an entirely new idea, as it has been previously described in communications to trade papers. It is now, however, for the first time regularly applied to a manufactured line of shapers, so it is worth while bringing it again to the attention of our readers. This front acting table feed is being applied to the line of shapers built by Gould & Eberhardt, of Newark, N. J.

The condition to be remedied is graphically shown in Fig. 1. Here we have a workman squaring down a shoulder in the shaper. He has to operate both cross and down-feed handles, and, at the same time, has to keep an eye on the lines he is working to, scribed on the front face of the casting. With the handles placed as they are, this necessitates a bodily contortion which is far from agreeable or profitable. To remedy this, an additional connection for the cross feed is made. This is a shaft at right angles to the table and screw, having a crank handle at the front of the work table. With this, as shown in Fig. 3, the operator can place himself squarely in front of the machine, with both cross and down-feed handles in easy reach, and in a position to see surely what he is doing.

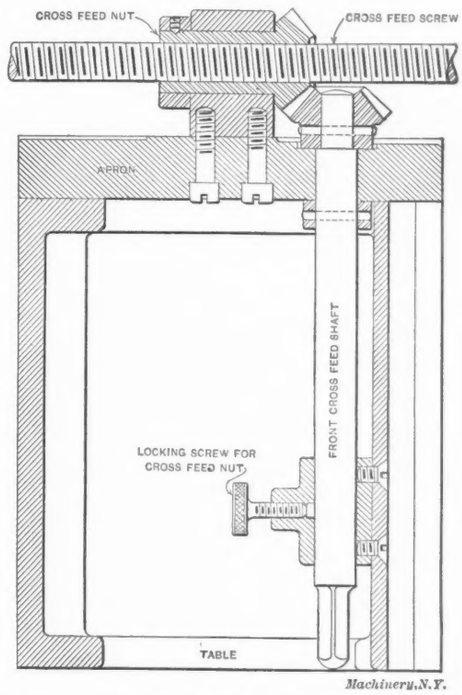


Fig. 2. Arrangement of Device used to work Cross Feed from Front of Table, as shown in Fig. 3.

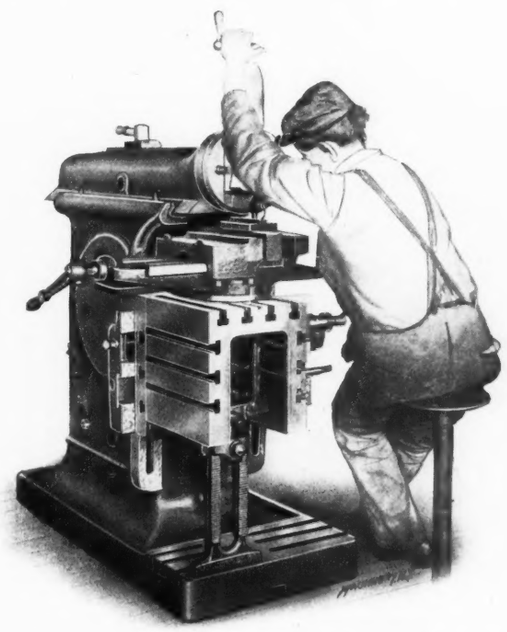


Fig. 1. Awkward Position which must ordinarily be assumed by the Operator in watching a Cut requiring both Down and Cross Feeds.

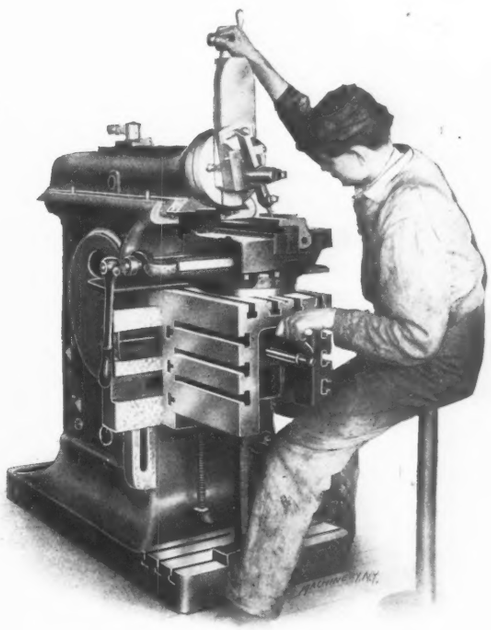


Fig. 3. Comfortable Position Possible with "Natural Way" Attachment, furnished with Gould & Eberhardt Shapers.

The device is so simple as to hardly need an explanation, but it is more plainly shown in the line drawing, Fig. 2. The cross-feed screw controls the table by acting on the cross-feed nut. This nut is journaled in a box screwed to the table, and carries a bevel gear at its right-hand end as shown. This bevel gear meshes with a mate which is pinned to the front cross-feed shaft, running out to the front of the table. This

shaft is squared, as may be seen, to fit the crank by which it is operated.

The lock screw shown has a cylindrical end, adapted to clamp the front cross-feed shaft and prevent it from turning. When the cross-feed shaft is so engaged, the cross-feed nut is stationary, and the table may be fed back and forth by the cross-feed screw in the usual manner. When, however, it is desired to use the crank on the shaft running out to the front of the table, the lock screw is turned back, so that the nut may revolve freely. The feed-screw then being stationary, the revolving of the crank, as shown in Fig. 3, feeds the table at the will of the operator.

BARNES FRICTION DRILL PRESS WITH COMBINED FOOT AND HAND FEED.

We show herewith an application of a combined foot and hand feed to the 10-inch friction drill made by W. F. & John Barnes Co., 231 Ruby Street, Rockford, Ill. The foot lever for operating this spindle is particularly useful for work requiring light drilling, which is yet so bulky as to need the use of both hands in holding and shifting it. As may be seen, the device is an addition to the regular hand feed, and does not supersede it. A lever having a segment of a gear formed on its outer end meshes with a pinion on the rack and pinion feeding shaft. The rear end of this lever is connected with the treadle by a long reach rod. Three different holes are provided in the treadle for attaching the reach rod, so that provision is thus made for applying varying degrees of power for drills of varying diameter.

Foot-operated Feed, applied to Barnes Friction Drill Press.

SMITH MICROMETER ADJUSTABLE REAMER.

The reamer shown in Figs. 1 and 2, made by the Wm. J. Smith Co., 424 State Street, New Haven, Conn., is called the Smith Micrometer Adjustable Reamer. It gets its name from the graduations provided on the body of the reamer, read by an adjustable sleeve in the same way that the readings for a micrometer caliper are obtained.

Aside from the blades, the tool consists of but three parts, shown disassembled in Fig. 2. These are the body and head of the reamer (formed in one piece), the adjusting sleeve, and the clamping screw. The blades are fitted in tapered slots cut in the head of the reamer. The adjusting sleeve is threaded to the shaft with a thread of fine pitch. It has a

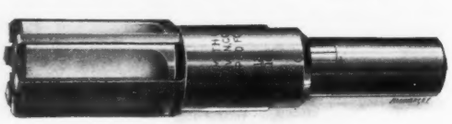


Fig. 1. The Smith Micrometer Adjustable Reamer.

cone-shaped inner surface, which engages the beveled ends of the blades, and holds them down to the bottom of the slot. The outer ends of the blades have under-cut bevel projections, which engage an internal cone-shaped surface under the head of the clamping screw. This clamping screw is threaded into the body, and serves to bring all the blades down to a firm and rigid bearing in the bottom of the slots.

In making adjustments, use is made of the graduations provided on the shank of the reamer. These are read from a zero mark on the sleeve, and give readings to one-quarter of a thousandth. To change the adjustment, the tightening screw is loosened, the adjusting sleeve is rotated to make the reamer larger or smaller by the desired number of thousandths, and the tightening screw is again set down firmly.

No threads are exposed in this reamer, all the adjusting parts being protected, leaving the exterior surface smooth and symmetrical with ample chip room for doing clean, fast work. The reamers are made throughout of high carbon steel, tempered to give the required hardness for resisting strain and wear. All the parts are interchangeable. The reamers of this type are made and carried in stock in sizes from ¼ inch to 1 inch in diameter inclusive, varying by 32nds. Special sizes, of course, can be made to order. Micrometer adjustable reamers for tapered holes are also made on the same plan.

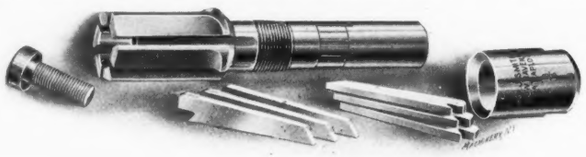
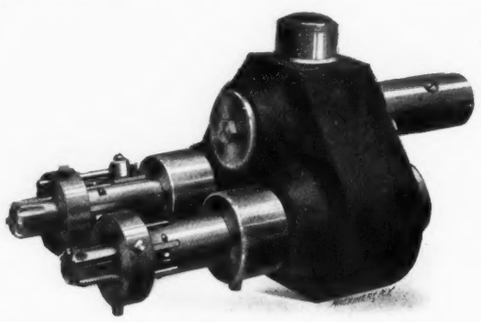


Fig. 2. Component Parts of the Reamer, showing the Simplicity of its Construction.

The blades used in these reamers are ground in the same way as described for the maker's "one lock" adjustable reamer in the October, 1907, issue of MACHINERY. As there explained, the blades are ground in a cylindrical grinder in a special arbor or fixture, which gives radial or eccentric relief to the work cutting edge of the blade. This form of relief will cut without chattering in all kinds of metal in which reaming can be done. Twelve jigs are required for covering the entire range of reamer sizes from ¼ to 1 inch diameter. These are furnished by the makers, or, if desired, blades may be sent to them for resharpening. This will be done at a nominal cost. A complete stock of interchangeable blades is carried by the builders, fitted and ground ready for use. The reamer bodies do not need to be returned for sharpening the blades or for fitting in new ones. They will be furnished of either carbon or high speed steel. Blades may be reground in the usual way if desired, but the special method devised for these reamers gives more satisfactory results.

MURCHEY DOUBLE COMBINATION TAPPING AND REAMING ATTACHMENT.

The device shown in the accompanying engraving was designed primarily for reaming and tapping two one-inch standard pipe threads at a time, in cast iron heater sections, such as are used in blower heating systems. It is built by the Murchey Machine and Tool Co., Fourth and Porter Streets, Detroit, Mich.



An Attachment for Reaming and Tapping Two Holes at the Same Time without changing Tools or readjusting Work.

The two spindles of the attachment are connected by gearing with the driving spindle, which is revolved by the machine in which the tool is used. Each spindle carries a combined reaming and tapping head, by the use of which the holes in the headers can be finished without changing the tools. The tap is of the collapsible variety. When the tool is

first run through the holes, the chasers are withdrawn, allowing the reaming blades to do their work. The second time it is forced through, the chasers are in their working position, and the threads are tapped in the holes. When the proper depth has been reached, as determined by the threaded stop rods, the taps automatically collapse, and the tool may be withdrawn without requiring the spindles to be reversed. This saves a great deal of time, as compared with the reversing spindle machines employing solid taps formerly used for this work.

Though intended for the particular work mentioned, this attachment will be furnished by the builder to do work of any size, within a reasonable range. Taps of the kind used in this device, are furnished by the manufacturers in sizes to cut standard pipe threads from 1-inch to 12-inch, and they are used in all kinds of tapping machine and Monitor lathe work.

HOLROYD DRILLING MACHINE AND GRINDING MACHINE.

The machine illustrated in Fig. 1 is more especially intended for drilling the flanges of pipes and fittings. On a strong base is mounted an upright carrying the drill head-stock. At right angles is another base embodying the table slides. On the table is mounted a revolving square table. The head-stock carries a hard steel spindle 2 inches diameter which has an automatic feed of 12 inches by means of drop-out worm and wheel which is released by an adjustable knock-off. The spindle is bored No. 3 Morse taper and is driven through spur and bevel gears by a four-speed cone for 3¼-inch belt, the diameter of the speeds being 10, 11, 12, and 13 inches, giving speeds of 241, 287, 342, and 407 revolutions per minute. Quick hand traverse is by rack sleeve and pinion actuated by hand-wheel. The self-acting feed is 1/100 inch per revolution of spindle. The spindle has a vertical adjustment on the column of 36 inches, with a similar cross traverse, both operated by screws and conveniently placed hand-wheels. The table slides are gibbed to the bed, the longitudinal traverse of the table being 12 inches. The revolving table is 3 feet

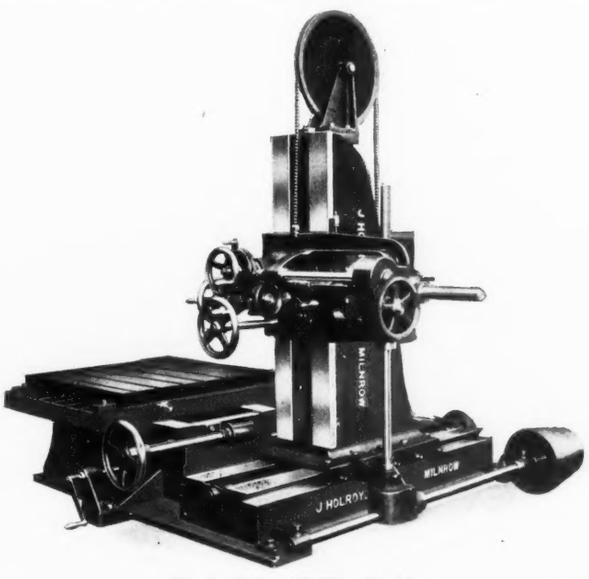


Fig. 1. Holroyd Drilling Machine.

square. The counter-shaft carries 12-inch by 4¼-inch pulleys, and runs at 470 R.P.M. The floor space required is 10 feet by 8 feet, and the total weight of the machine is 3 tons, and, as in the case of the bushing grinding machine illustrated in Fig. 2, the tool is built by John Holroyd & Co., Ltd., Milnrow, Manchester, England.

The second machine mentioned is specially designed for grinding the inside of bushings and cutters from 2 to 6 inches diameter, and up to 12 inches long. It has a strong body with facings provided to receive the spindle and table slides. The emery wheel spindle of hard steel runs in gun-metal bearings carried in the cast iron sleeve. The spindle is driven from a 12-inch diameter pulley for a 1½-inch belt onto a two-speed cone connected to a drum pulley 7½ inches diameter, which in turn drives the spindle pulley. The spindle slide is balanced and provided with self-acting vertical feed of 12 inches, adjustable stops being provided to reverse the feed at any desired point of the traverse. The feed is obtained from the main cone driving shaft through a series of gears onto rack and pinion. Hand cross adjustment of the spindle

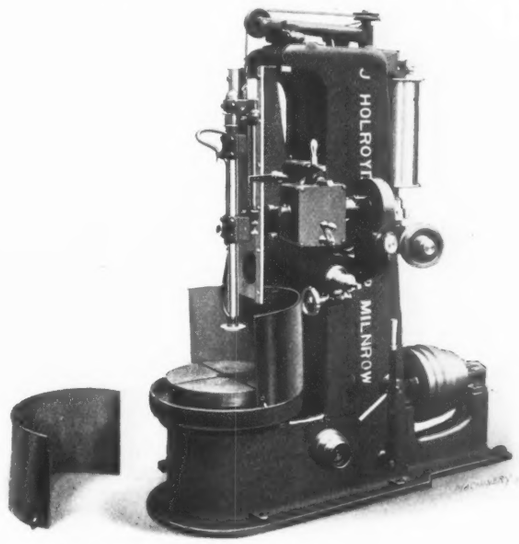


Fig. 2. Holroyd Bushing Grinding Machine.

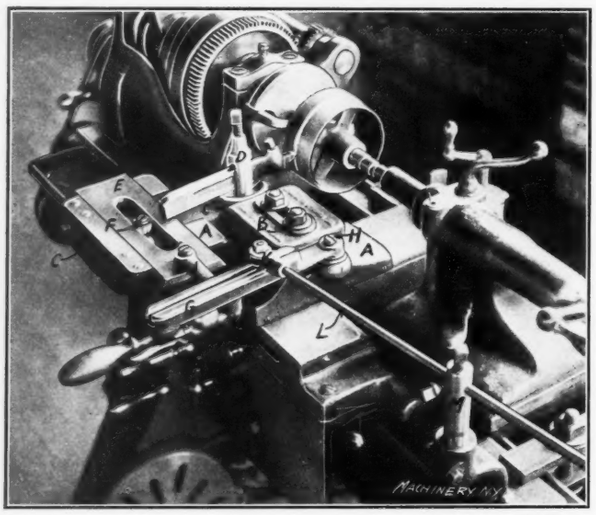
is provided, a micrometer disk being arranged to read to 1/1,000 inch. The work table is 18 inches diameter and has four tee-slots. The table drive is through spur and bevel gearing from a three-speed cone for 2¼-inch belt, the largest speed being 12 inches diameter. The table drive may be brought into or out of action independently of the rest of the machine, by lever and clutch, an advantage when gaging the work being ground. A hinged guard is fitted to prevent the lubricant splashing. The emery wheel speeds range from 6,900 to 10,800 R.P.M., and those of the table are 66, 100, and 150 R.P.M. The feeds per revolution of work are 0.166, 0.25, and 0.375 inch. The counter-shaft pulleys are 12 x 3¼ inches, and the speed 400 R.P.M. The floor space occupied by the machine is 5 feet 6 inches by 3 feet 8 inches, and its weight 2,900 pounds. J. V.

MOSSBERG PULLEY CROWNING ATTACHMENT FOR LATHES.

In the half-tone is shown a pulley crowning attachment, made by the Mossberg Wrench Co., of Central Falls, R. I. The notable features of this attachment are that it is adapted to turning suitable crowns for narrow or wide-faced pulleys, without requiring a change of formers, and that it is also adapted for being attached to a wide range of sizes and designs of lathes, without requiring reconstruction. A number of other advantages will appear in the course of the description.

It consists essentially of a main casting *A*, clamped by bolts *B B*, to the regular tool-post slot of the cross-slide. This main casting carries ways for slide *C*, on which the tool-post *D* is mounted, and also ways at right angles to, and above *C*, for confining former *E*. This former has a curved slot, operating on a roll *F*, whose pivot is fast to the tool-post slide *C*. It will thus be seen that a longitudinal movement given to former *E*, will, through the action of the curved slot on roll *F*, give an in and out movement to the tool-post, thus determining the contour of the surfaces being turned. This longitudinal movement is given by the link work shown. A bar *G*, pivoted at *H* to the main casting *A*, is connected with *E* by the link *J*. It carries a handle at its outer end, and its upper surface has a T-slot on which pivot *K* can be adjusted to any desired position. This pivot constrains the end of rod *L*, whose other end is fastened, at any length desired, to an adjustable bracket *M*.

As the carriage is moved back and forth, it will be seen that rod *L* will swing slotted bar *G*, which, through link *J*, will move the former *E*, thus affecting the turning tool and the contour of the work. If *K* is adjusted to position immediately over the connection point of link *J* in the slotted bar, then the former will stand stationary with relation to the bed of the lathe, while the carriage and the tool-post move back and forth by the feed or by hand. Under these conditions, the contour of the slot in the former will be exactly traced on the face of the pulley. If pivot *K* is clamped in the position shown, the swinging movement of *G* will be much greater for a given movement of the carriage, so that a shorter and more pronounced curve will be turned, suitable for narrow faced pulleys. If the



Attachment for Crowning Pulleys, which gives Curves Suitable for Pulleys of Different Faces with the Same Former.

pivot, on the other hand, is located at the extreme outer end of the slot in *G*, the movement of the former will be very much slower, and the conditions will be suitable for turning pulleys of wide faces which do not require a pronounced crown. This makes unnecessary the provision of a former for each shape of crown desired.

Another advantage of this device is the fact that special arbors with shoulders for locating the work are not required. In operation, when it is desired to start on a new pulley, the carriage is adjusted until the tool point is central with the face of the pulley; the set-screw in pivot *M* is then released, and slotted bar *G* is adjusted by the handle at its outer end until roll *F* is in the center of the slot in *E*, as determined by the center line traced upon it. The set-screw in *M* is then tightened down again, and the tool brought over to commence the operation of turning.

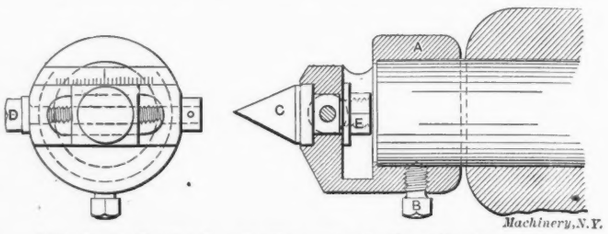
These features, and the self-contained construction of the attachment, should make it convenient for the work it is designed for.

CINCINNATI CENTER FOR TURNING TAPERS.

The device shown herewith has been designed by Max C. Zange, 2827 Sidney Avenue, Cincinnati, Ohio, for doing away with some of the troubles incident to turning tapers in the lathe by the method of setting over the tail-stock. One of the chief difficulties in turning tapers in this way, as is well known, is the fact that the center adjustment of the tail-stock is disturbed, and it requires considerable time and trouble to bring it back, after the taper job is completed, to a position where the lathe will again turn work to the required degree of cylindrical truth. With this device the tail-stock is not set over, the setting over being done on the center itself, provision being made in the attachment for this.

The body *A* of the device, machined out of round stock, is clamped to the tail-stock spindle by set-screw *B*, the regular tail center being removed for the purpose. The tail-stock spindle seats against a shoulder in *A*, to take the thrust of the work between the centers. The front of the body of the device is milled out to form ways in which the center *C* can be laterally adjusted. The lateral movement of this center is effected by the stationary adjusting screw *D*, and the amount of off-set is read by graduations on the body, as shown in the end view. After the required adjustment has been obtained, the center is clamped in position by nut *E*, which is reached by the wrench through the opening in the body left for the purpose.

The center is made of tool steel, hardened, and is made to an angle of 50 degrees instead of the usual 60 degrees of the



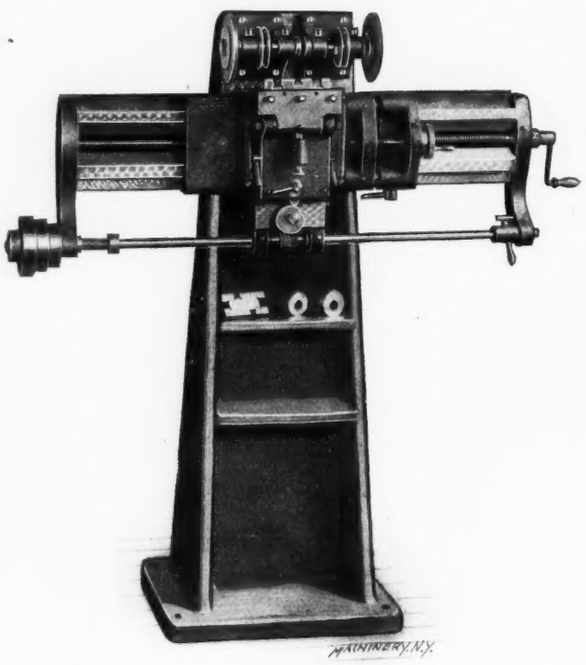
A Device for Setting Over the Tail-center for Taper Turning, without disturbing the Adjustment of the Tail-stock.

common lathe center. The pointed end is also slightly curved, both of these alterations being made to compensate for the angular position of the center in the work. The adjusting screw *D* has 25 threads per inch, and this pitch, in connection with the squared head of the screw, may be used in obtaining adjustments of hundredths of an inch.

Two sizes of this device are made, one of them suitable for bench and precision lathes, and the other adapted for larger machines. In the smaller one, the nut *E* is provided with a permanently fixed handle, so that it is not necessary to insert a wrench in the opening when the center is to be tightened in position. The small size is suitable for tail-stock spindles up to 1⅜-inch outside diameter; the larger size will cover the range of from 1⅜ to 1 15-16 inch outside diameter of tail-stock spindle.

GAGE LAPPING MACHINE, BUILT BY THE WALTHAM MACHINE WORKS.

We show herewith a machine for lapping gages, built by the Waltham Machine Works, Newton St., Waltham, Mass. It is intended for doing the work described in the article on machine lapping by Mr. Shailor in our November, 1907, issue.



A Machine for Grinding Snap Gages, and Finishing them by Lapping.

It will be remembered that the use of the milling machine was there spoken of for this work. This specialized tool accomplishes the same results in a somewhat more convenient way. The upright column of the machine supports two heads,

one of them carrying a spindle for a grinding wheel, and the other for a steel disk charged with emery or diamond dust, for the finishing operation of lapping. Since these arbors are run separately, appropriate speeds can be given to them. The gage to be ground is held in a vise, carried by a slide adjustable on the cross-rail, shown at the front of the column. The crank at the right, attached to the traversing screw, affords means for changing the work from the right-hand wheel to the left-hand, or vice versa. The small adjusting wheel is attached to a fine pitch screw, which is used for feeding the gage up to the wheel for the grinding or lapping operations.

In operation, the gage is brought up to the revolving disk with just enough pressure to give a suitable cutting action. The vise in which the work is mounted slides in vertical ways, and a vertical reciprocating motion is given to it by means of the heart-shaped cam shown, driven by worm gearing from a shaft running lengthwise of the cross-rail, below it. This cam does not give a uniform movement throughout the stroke. It accelerates its motion at the ends of the stroke to avoid the "bell-mouth" effect which is ordinarily seen in lapped gages. The holder or vise in which the gages are mounted can be swung outward at an angle of 45 degrees for gaging the work. A clutch is provided for stopping the cam driving shaft, without requiring the counter-shaft to be stopped.

This machine is built only to order by its makers. The one shown is quite elaborate and was so made to meet the requirements of the purchaser. Simpler machines of the same sort for lapping gages could be designed, and the makers will furnish them adapted to suit individual needs.

TOLEDO TOGGLE ACTION DRAWING PRESS OF UNUSUAL SIZE.

The Toledo Machine & Tool Co., of Toledo, Ohio, has recently shipped to one of its customers, what is believed to be the largest toggle action drawing press ever built. The machine is certainly of tremendous size, as will be seen by comparing it with the man who stands in the foreground of Fig. 1. It has interest aside from its unusual size, from the improved construction of the toggle mechanism (described also in the December, 1905, issue of MACHINERY), which gives a long "dwell," and is unusually efficient so far as power consumption is concerned. The press is intended for deep stampings in steel or other materials, particularly for brake drums for automobiles, sinks, bathtubs, and similar work.

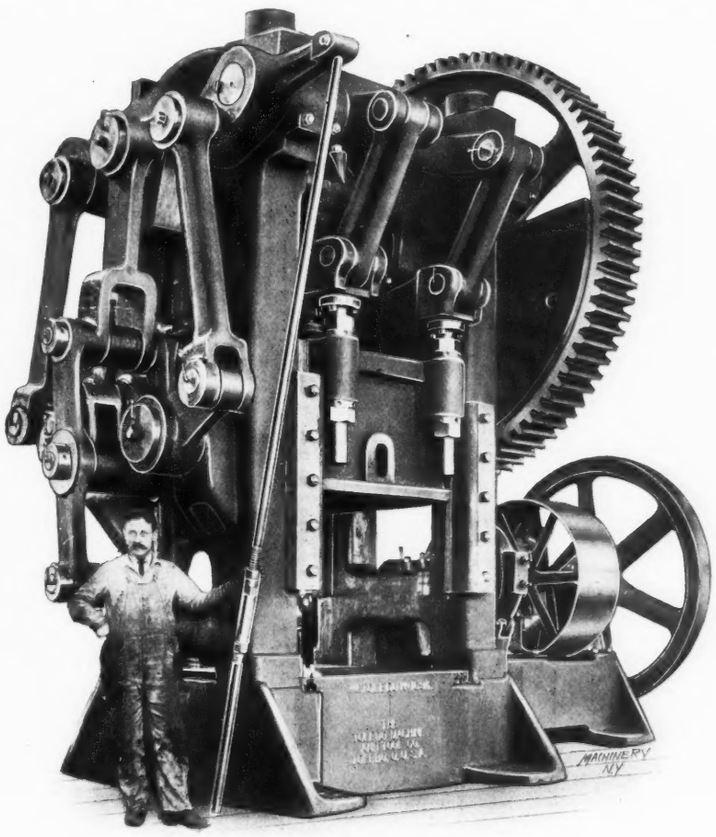


Fig. 1. Heavy Drawing Press with Blank Holder operated by a Toggle Mechanism.

The toggle mechanism, which is plainly shown in the halftone, Fig. 1, and the line drawings, Figs. 2 and 3, is of such

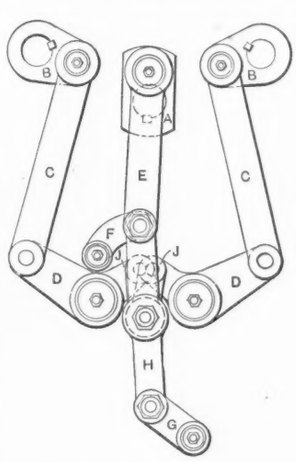


Fig. 2. The Outside Toggle Mechanism in the Position to raise the Blank Holder.

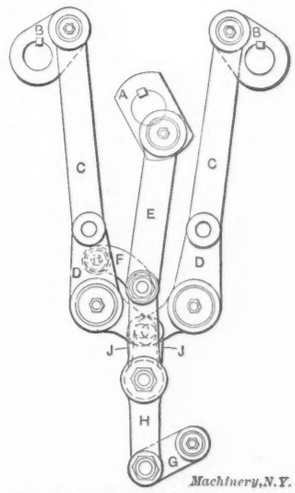


Fig. 3. The Toggle Mechanism while the Blank Holder is Lowered.

design that all sliding surfaces are eliminated, being replaced at all points with pivoted joints, most of which have but a very small angular movement. *A* (see Figs. 2 and 3) is a crank keyed to the main crank-shaft of the press. Connecting-rod *E*, attached to this, is pivoted in yoke *H*, which is suspended on rocker arms *F* and *G*, pivoted to the side frames of the machine, on opposite sides of *H*. Bell crank levers *D* are operated from the center pivot of *H*, through short links *J*. Links *C* connect the upper arms of bell cranks *D* with cranks *B*, which are keyed to rocker arm shafts. The rocker arms between the frames are directly connected with links to the blank holder slide, as snown in Fig. 1.

A comparison of Figs. 2 and 3 will show the action of the mechanism. In Fig. 2, crank *A* is at its highest position. In Fig. 3 the blank holder is down. It will be seen that in this position bell cranks *D* and links *C* are straightened out, so that a powerful toggle action with an appropriate dwell is obtained, lasting through a considerable portion of the revolution of the crank-shaft.

Cranks *B*, in turn, operate the rocker arms, which, with the links connecting them with the blank holder slide, form a second toggle joint mechanism. It will be seen that these two sets or toggle joints, acting in series as they do, give a powerful pressure to the blank holder, estimated by the builders at 2,000 tons. This gives a very long dwell as well. This extends to over 90 degrees of the crank action, without perceptible movement of the blank holder.

All the parts of the toggle mechanism are made of steel castings, and each bearing is bushed with bronze. The bearings of the outer movement are oiled through the ends of each of the pivots, by means of self-oiling or compression cups. The smoothness and ease of action obtained by this thorough lubrication and by the avoiding of sliding surfaces, allows the machine to be driven with an 8-inch belt, though it was supposed that a 10-inch double belt would be necessary. The press is operated by a powerful friction clutch, and is therefore under complete control of the operator at all points of the stroke of both plunger and the blank holder.

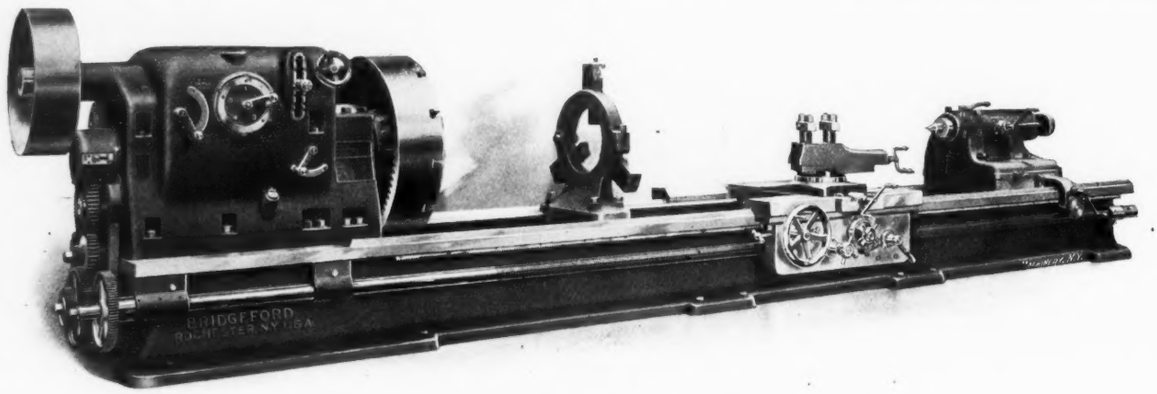
The distance between the uprights is 57 inches, this being also the width of the bed. The distance from the bed to the

blank holder, with the stroke down and the adjustment up, is 24 inches. The distance from the bed to the plunger with the stroke down and the adjustment up is 28 inches. The stroke of the plunger is 26 inches. The belt pulleys are 58 inches in diameter, designed for a 10-inch belt, and are intended to run at 250 revolutions per minute. This, with a gear ratio of 50 to 1, gives 5 strokes per minute for the press. The shaft is 13 inches in diameter at the crank bearing.

The total height of the machine above the floor line is 21 feet. It weighs, complete, 175,000 pounds.

BRIDGEFORD GEARED HEAD LATHE.

The Bridgeford Machine Tool Works, Rochester, N. Y., has recently designed a line of geared head lathes covering the sizes between 26 and 48 inches swing. The engraving shows the 42-inch lathe. The 48-inch swing is, so far as our memory serves us, the largest single speed pulley geared head lathe we have even seen illustrated or described. The lathe has been designed to meet the severest requirements, and is claimed to be limited in capacity only by the efficiency of the best of the modern high speed tool steels.



A Geared Head Lathe of Unusual Size, built by the Bridgeford Machine Tool Works.

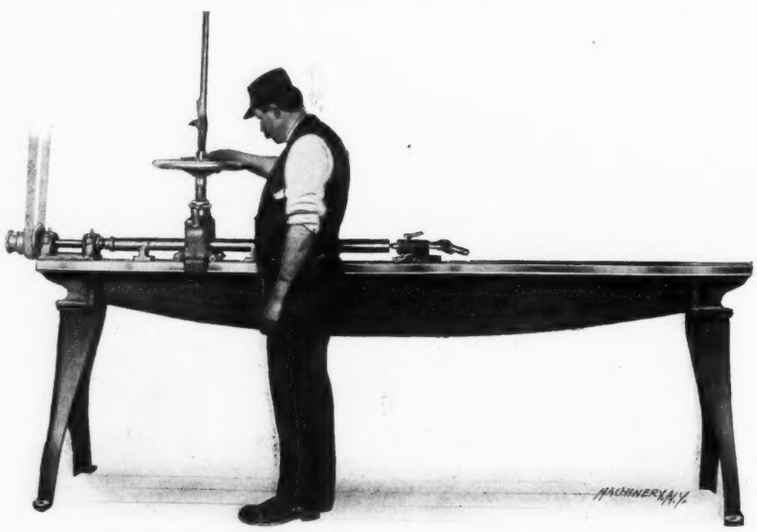
The power is applied to a constant speed pulley from which the 15 cutting speeds are obtained by change gearing. These speeds are arranged in geometrical progression, and the changes are accomplished by shifting the conveniently located levers, shown in the half-tone in front of the head-stock. All the driving gears, with the exception of the face-plate gear, are of steel cut from the solid. All those within the head run in oil, and provision is made for furnishing a constant supply of oil to all the bearings. The proportions of gearing used give from 2.26 to 110.8 revolutions of the driving pulley to 1 revolution of the face-plate. On a diameter of 42 inches the pulling power is about 25,000 pounds, or about four times that of the ordinary cone driving lathe. The spindle is of crucible steel, ground to size, running in heavy bronze bearings scraped to fit. The face-plate is pressed onto the spindle and keyed to it.

The bed is of ample width and depth, and is strongly reinforced with heavy cross ties of box pattern. It is also provided with a longitudinal rib with ratchet teeth cast in its upper face, which engage a pawl at the back of the tail-stock. This provides a positive stop for the tail-stock, which is a great advantage when the lathe is engaged on heavy work. The tail-stock is so shaped as to clear the compound rest when turning angular work. The carriage compound rest and apron are of heavy construction, and in keeping with the balance of the lathe. The direction of the feeds is changed at the apron, and the lateral and cross feeds are driven by independent frictions.

The following dimensions will give some idea of the rigidity of the design. The main spindle bearing is 8¾ inches in diameter and 14 inches long, with a 1 7/16-inch hole through it for removing the center. The centers are of tool steel, 3 3/16 inches in diameter. The 42-inch face-plate is 11 inches wide. The driving pulley is 30 inches in diameter, for an 8-inch belt. The lead-screw is 2 11/16 inches in diameter, two threads to the inch, and the rack is 2 inches wide, 5 diametral pitch. With a 16-foot bed, the distance between centers is 6 feet 7 inches. It can be built with a bed of any length desired. A 42-inch lathe with a 16-foot bed weighs 27,000 pounds; 6,500 pounds should be added for each additional foot of length. The regular attachments are: Compound rest, side-turning rest, 16-inch center rest, thread indicator, change gears, self-oiling counter-shaft, and the necessary wrenches and cranks.

ROCKFORD DRILLING MACHINE COMPANY'S STRAIGHTENING MACHINE.

The machine shown in the accompanying engraving is a combination of lathe and straightening press, for straightening centered work. Straightening presses have been built to use in the lathe, and straightening presses have been built provided with centers on which to spin the work to determine the "high spots," but this is the first device that has come to our attention that is really a combination of the straightening press and lathe. It would seem to be a very efficient machine for use in places where there is considerable of this work to do. It is built by the Rockford Drilling Machine Co., Rockford, Ill.



A Combination of Lathe and Screw Press for Straightening Centered Shafts.

The machine consists essentially of a heavy, rigid bed, carrying a power driven head-stock and an adjustable foot-stock, and supporting a straightening press with suitable blocks for the straightening operation. The head-stock spindle has a

three-step cone, on which the belt may be shifted to drive the work at a rate of revolution suitable for accurately determining its truth. A center is supported by this spindle in the front end in the usual way. Instead, however, of driving the work from a face-plate by a dog, a friction device is provided which revolves the work as soon as it has been clamped between centers. This consists of a collar fitting over the head-stock center, and provided with a leather face which is pressed against the work by four coiled springs. The support blocks used are provided in sets of two for each diameter of shaft. They are bored to accurately fit the diameter they are made to, but with centers 1/16 inch or thereabout below the center of the spindle. The tail-stock center is operated by a lever, and may be held in position by a clamp screw in the ordinary way. It will be seen that this method of supporting and driving the work is very convenient, since when the centers are released, the work drops into position in the supporting blocks, ready to be straightened. After the straightening is done and the tail-center is again brought up and clamped, it raises the work from the supporting blocks, the centers enter the center holes in the work, and the work is driven by the constantly running spindle, all of this being done in one movement of the tail-stock operating and clamping levers.

The carriage which supports the straightening screw runs on rollers, and can be shifted very quickly and easily on the bed to bring it to the point where the straightening needs to be done. This screw is of fine pitch, so that the hand-wheel provided is generally of sufficient diameter for providing enough pressure to straighten the work. For large work, however, the ratchet lever shown may be swung down into place, giving sufficient leverage to straighten any piece within the capacity of the machine. On this straightening screw is fixed a revolving dial, read from a stationary index point. The operator watches this in straightening a piece of work, and is able to use it for reference in applying pressure a second time to the same point, if the first application of the pressure was not sufficient. The bed is very rigid, and capable of sustaining as severe a straightening pressure as should be applied to any work within the capacity of the machine. It is long enough to give the machine a capacity of 8 feet between centers.

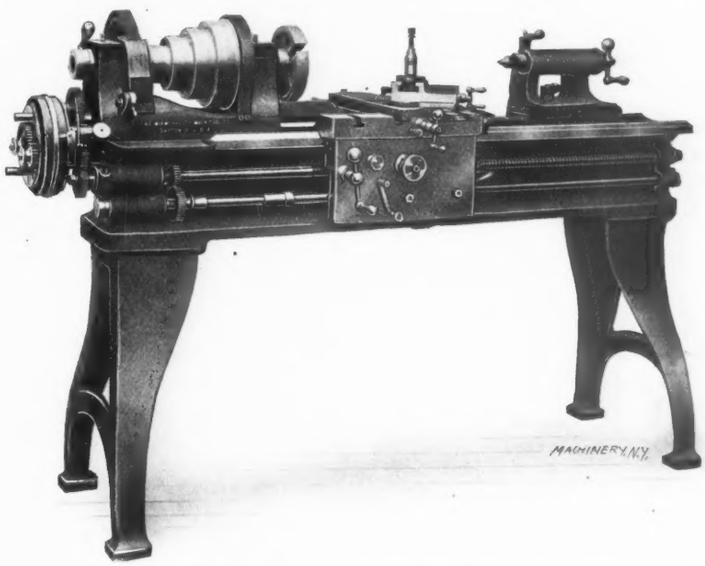
The builders have been using this machine to do all of their straightening with, none of it now being done in the lathe in their shops. They have found that it permits doing the work in a very much shorter time, owing to the convenience of operation which the design of the machine provides for. All of this straightening is best done by one man, who soon becomes skillful at the work, so that it is done in a small fraction of the time previously required.

IMPROVED MIAMI VALLEY 13 1-2 INCH ENGINE LATHE.

The machine shown in the accompanying engraving is an improved design of the lathe built by the Miami Valley Machine Tool Co., 843 W. Germantown St., Dayton, Ohio. Among the improvements made are: the addition of a quick change gear attachment; an automatic stop for the carriage feed; a chasing dial for cutting screw threads; and a taper-turning attachment.

The general design of the lathe is simple, rigid and serviceable. The spindles are of high grade crucible steel, ground accurately to size, running in bronze bearings. The head- and tail-stocks are of heavy design, and are held to the bed with a V-bearing at the rear, and a flat bearing on the front; the carriage has a V-bearing in the front, and a flat bearing in the rear. There being but one V-bearing in front, the carriage may be stiffened materially without decreasing the swing. The chasing dial is located just at the right of the carriage. It is connected to a worm-wheel meshing with the lead-screw, and the graduations on its face are used to determine the proper time for throwing in the lead-screw nut when cutting threads. The use of this dial makes it unnecessary to reverse the counter-shaft for thread-cutting. An interesting point in the construction of the compound rest is the fact that the screw is journaled in the swivel base, while the nut is fast to the tool-post slide. It is thus possible to lubricate the latter.

The quick change gear attachment shown is the well-known one designed by the National Machine Tool Co. It consists of a series of change gears, of various numbers of teeth, arranged in a circular casing and engaging with a central intermediate gear. Changes are made by rotating the casing and engaging the different gears in it with the lead-screw in different positions, and by placing the slip gear on the outside of the casing on the desired one of the various studs provided for it. The number of threads that can be cut varies from 4 to 56 per inch, including the 11½ per inch pitch for pipe threads.



Miami Valley Lathe, as arranged with Quick Change Gear Device.

This machine, which is built in the 13½-inch size, may be had in three lengths of bed—5, 6, or 8 feet. The lathe, with an 8-foot bed, weighs 1,450 pounds. The machine is regularly provided with the compound rest. A taper attachment, carriage turret, and quick change gear device are provided extra when desired.

MILLING MACHINE ATTACHMENT FOR CHAMFERING TRANSMISSION GEAR TEETH.

In the speed change mechanism used in the automobile, the changes are usually obtained by a sliding gear mechanism of some form. To facilitate the sliding of the gears into mesh when they are running at considerable speed, it is usual to chamfer the ends of the teeth, to guide them in entering into mesh with each other. Sliding gear mechanisms are coming into more frequent use in machine tools, so that a machine or attachment like that illustrated (for performing this operation of chamfering the ends of the teeth) is of wider interest than to the automobile industry alone. The device illustrated in Figs. 1 and 2 is built by the "Long Arm" System Co., Cleveland, Ohio. The attachment is fastened to the milling machine table, and its driving pulley is belted to a special counter-shaft. The mechanism is automatic in its action. All it is necessary for the operator to do is to place the work on the work-spindle, adjust the machine and the work properly, and start the counter-shaft. The mechanism revolves the work, feeds it up into the cutter, retracts it—and so on until the work is completed.

The cast iron frame of the device is in the form of a knee, which is bolted to the table. To this frame, on the front side, best seen in Fig. 2, is attached a bracket carrying the driving pulley shaft. A pinion on this bracket drives a gear, which

is connected with a face cam of the enclosed groove type. This cam gives movement to the vertical slide which carries the work spindle. It serves to feed the work upward into the cutter and return it again while it is revolving for the next tooth. This cam gear is connected by an intermediate with the gear driving the indexing worm, the cam and the indexing worm being geared to run together at the same number of revolutions per minute. The gear is its own index wheel. The index worm is adjusted in the T-slot provided for it in

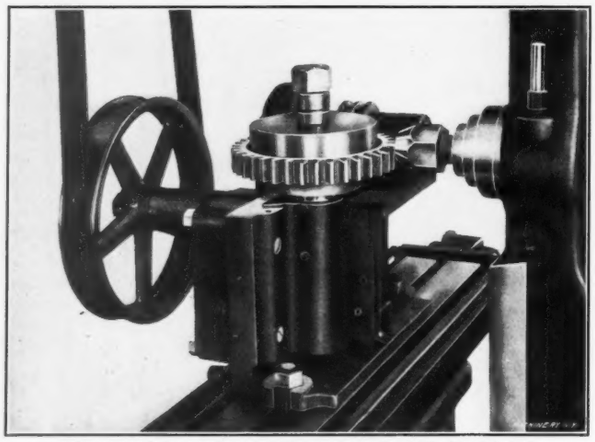


Fig. 1. The "Long Arm" Automatic Gear Tooth Chamfering Attachment at Work.

the body of the fixture until it meshes properly in the teeth of the gear to be cut, and it is clamped in this position, the intermediate gear from the cam shaft being adjusted to drive it without back lash.

When the machine is thus arranged, it may be driven continuously from the counter-shaft. The rotation of the driving pulley will then impart a constant rotary movement to the work through the index worm, the cam, meanwhile, raising and lowering it. With the cutter properly adjusted with relation to the work, it will be seen that this continuous action may be so planned that the cutter will trim off the corner of one side of a gear tooth as it drops into the tooth space, and trim off the corner of the other side as it comes out again, then drop into the next tooth space, beveling the corner as it does so, and continuing the work in the same way until the gear has been finished, and the work removed.

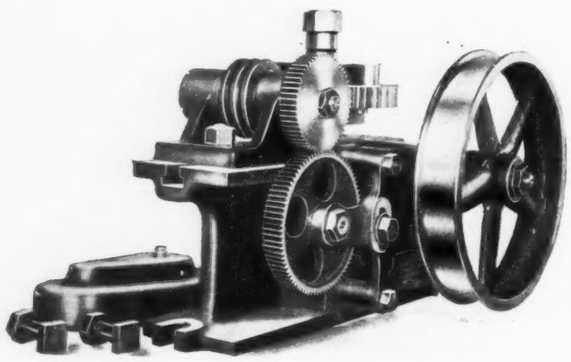


Fig. 2. Front View of the Attachment with the Gear Guard Removed, showing Mechanism.

In practice it is not necessary to stop the machine to put in the work or take it out again. The milling machine saddle is simply run back to withdraw the worm from the cutter, the nut on the end of the work spindle is loosened, and the work is removed. A new gear is then put in, the nut tightened, and the work again brought up to the cutter, when the attachment will continue in operation as before. The under side of the gear can be operated on by changing the position of the cam roll, to engage with the slot below the center of the cam instead of above it, at the same time altering the adjustment of the knee of the milling machine on the column to bring the work to the proper height.

In adjusting the device for gears of the same pitch but of different numbers of teeth, it is only necessary to adjust the indexing worm out or in to mesh properly with the new gear, and to set the machine so that the cutter is in the proper relation to the work. The same index worm will work properly with all gears of the same pitch within the capacity of the machine, a separate index worm being required for each pitch. The cutters used are double ended, of the formed end mill type, the body of the cutter being ½ inch in diameter. They may be held in the milling machine spindle by any collet adapted for holding ½-inch straight-shanked cutters. By using cutters of different shapes, different contours of chamfering may be given to the work.

The machine is well made. The worm is of hardened steel, as is also the work spindle and the cam with its cam roll. Means are provided for taking up any looseness endwise in the worm due to wear, and similar provision is made for taking up wear on the work slide. A gear guard is furnished to cover the intermediate and the worm-driving gears, thus protecting the operator from injury.

The capacity of the attachment is for work from 2 inches to 9½ inches pitch diameter, and from 4 to 10 diametral pitch. When run at the proper speed, about 12 teeth per minute can be chamfered or rounded. The attachment weighs about 80 pounds. A counter-shaft is provided having tight and loose pulleys and an idler pulley with an adjustable counterweight. The counter-shaft weighs about 90 pounds. The price of the machine includes the counter-shaft, clamping bolts, one indexing worm, one cam, two double end cutters, and bushings for locating and holding a gear of one size.

BETHLEHEM STEAM DROP HAMMER.

The Bethlehem Steel Co., South Bethlehem, Pa., has been for some time engaged in the drop forging business, making forgings from all grades of iron and steel to which the process is applicable. In fitting up the plant, it was at first equipped with board drop hammers of the best design and construction the firm was able to find at the time. These failed so seriously

Fig. 1. The Bethlehem Steam Drop Hammer.

and often on ordinary work, involving expensive repairs and delays, that it was finally decided that all future additions to the equipment should be of the type in which the drop is raised by the pressure of steam beneath the piston.

It had been considered in the first place that the steam hammer was more efficient and economical than the board

hammer, but experience with it had shown that it developed serious weak points in service, when of the usual construction. The Bethlehem Steel Co. therefore decided to design a hammer in which the various defects were eliminated, so far as possible, by skillful design and careful construction. The result of this decision is the steam drop hammer we herewith illustrate and describe.

Experience has shown that the steam drop hammer, as ordinarily made, has too small a ratio between the weights of the drop and of the base to permit the most efficient work. This is remedied by increasing the weight of the drop. To prevent the base from cracking under the greater strain thus put upon it, it is made of a steel casting instead of cast iron, as was the previous practice. Another difficulty met with is the rapid wearing of the bearing surface of the housings on the base. This is due largely to the abrasive action of the scale, which makes it impossible to keep the dies properly matched. These difficulties have been overcome by providing ample bearing surfaces, and designing the parts so as to prevent the lodging of scale and the wear consequent thereon.

The severe side thrust arising from forging out of the center of the dies, brings about very serious difficulties, such as the breaking of the guides and uprights, and the consequent bending or breaking of the piston-rod. To overcome these difficulties, the uprights have been tied together to prevent spreading, and to distribute the strains so as to minimize any eccentric action on the part of the drop, thus extending materially the life of the piston-rod. In addition, the substitution of steel castings in place of iron for the uprights has obviated all the danger of the breaking of these parts.

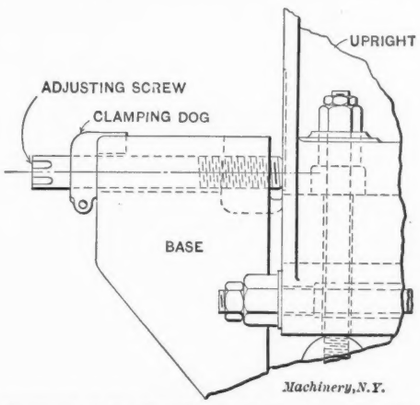


Fig. 2. Adjustment of the Uprights on the Base, for Centering the Dies.

In the ordinary steam drop, no provision is made for adjusting the dies in any other way than by the keys in the lower member. The screw and nut adjustment used in the board drop is short-lived, the screw either breaking or becoming fast in the nut. To replace these broken parts, it has been hitherto necessary to dismantle the hammer, an operation consuming from 1 to 3 days. On the Bethlehem steam hammer, as is shown in detail in Fig. 2, the screw and nut are made exceptionally heavy, and are so placed as to facilitate their renewal and the substitution of new ones in case of necessity—an operation requiring less than half an hour. The aligning of the dies, as may be seen, is effected by moving the whole frame-work of the hammer on the bed one way or the other, by operating the screws at the ends of the bed. These screws are locked by the dogs clamped to them, whose tails enter slots provided for them in the base.

The builders are prepared to furnish these hammers in any size from 500 to 10,000 pounds inclusive.

PEASE AUTOMATIC ELECTRIC BLUE-PRINT MACHINE.

The device illustrated in Figs. 1 and 2 is made by the C. F. Pease Blue-Print Machinery & Supply Co., 22 Fifth Avenue, Chicago, Ill. It consists essentially of a blue-print frame, mounted on pivots between uprights, and provided with mechanism for traversing at a uniform and adjustable speed across its face, an electric light of the Cooper-Hewitt type.

The printing frame is made of carefully selected hard wood, well finished and reinforced. The frame on which it is mounted is of iron, and is provided with a spring stop to hold the frame in the operating position shown in Fig. 1, or the position for removing or inserting the prints or tracings shown in Fig. 2. The lamp used, as is well known, consists of a hermetically-sealed glass tube containing a quantity of

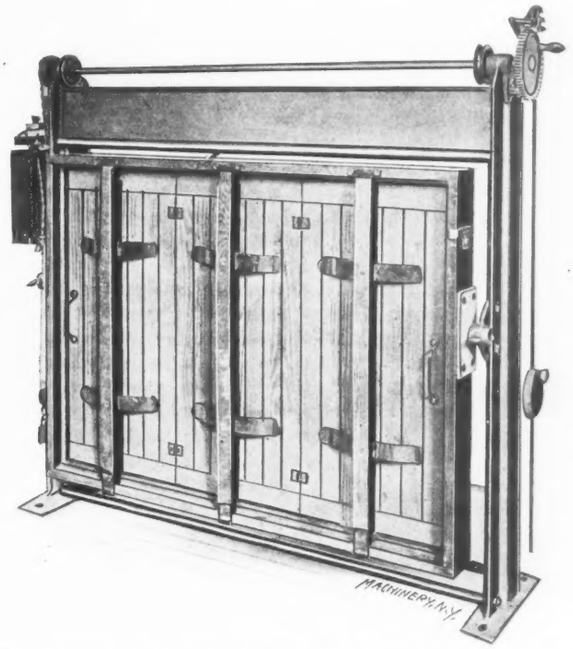


Fig. 1. Blue-printing Machine using Cooper-Hewitt Lamp, whose Descent is regulated by a Pendulum and Escapement.

mercury. As may be seen, the tube is placed in a slightly tilted position, with the mercury at the lower end. As soon as the current is established by throwing on the main switch, the tube is tilted by mechanical means provided for that purpose so that the mercury flows in an unbroken stream to the other end. When this has been done the tube becomes luminous throughout its length, and is then allowed to resume its normal position, as shown in Fig. 2.

The mechanism for traversing the tube across the face of the print comprises an escapement, regulated by a pendulum

Fig. 2. The Printing Frame swung down to permit Insertion of Tracing and Paper.

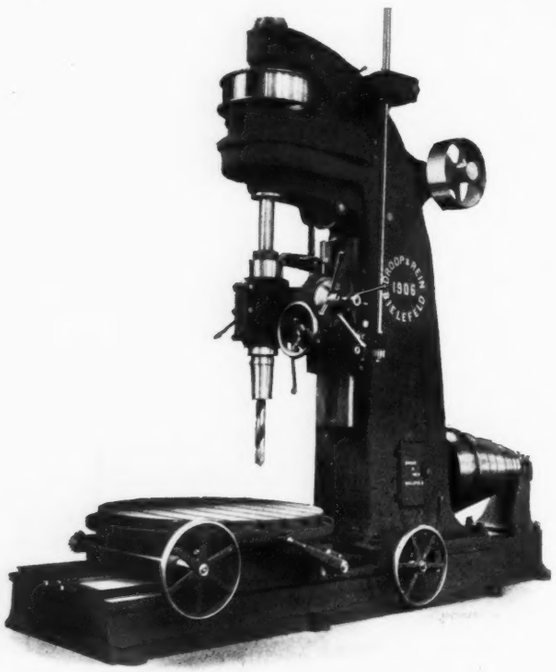
with an adjustable weight, which may be set to give the rapidity of printing required by the quality of the paper used, and the transparency of the tracing. The lamp is mounted in a well-ventilated reflecting box, not shown in the cut, guided between uprights on the main frame of the machine, and supported by cables attached to the speed controlling shaft at the top.

A number of advantages are claimed for this device. The machine is highly efficient as compared with those using arc lights. This is due to the use of the Cooper-Hewitt lamp, which gives about double the amount of light obtained from an arc lamp consuming the same amount of current. The amount of heat thrown off is also so small that the lamp may be placed close to the paper, so that the printing efficiency is much greater than with an arc lamp placed as far from the work as is necessary in a cylinder machine. The Cooper-Hewitt light is also very rich in chemical qualities, making it an ideal one for this use, since practically all the energy is transformed into actinic rays. It requires only 3½ amperes at 110 volts to print at the same speed as an arc lamp in a cylinder printer, consuming 15 amperes at the same voltage. A life of 2,000 hours is guaranteed for the tubes, and single tubes have been known to last twice this length of time. The cost of operating the machine is less than two cents per hour at the rate of five cents per kilowatt hour. The simplicity of construction and operation permits the machine to be handled by inexperienced help, an ordinary office boy being capable of running it to good advantage.

Three sizes of this machine are made for frames 20 x 24, 30 x 42, and 36 x 48 inches, respectively. They occupy floor space 12 inches in width, varying from 30 to 60 inches in length for different sizes. They are considerably less expensive than the cylinder type machines.

DROOP & REIN HIGH SPEED DRILL PRESS.

We show herewith an engraving of a businesslike-looking high speed drill press, made by Droop & Rein, Bielefeld, Germany. The frame of the machine is built in the form of a hollow housing, giving the tool the stiffness and strength necessary for drilling holes of large diameter with high speed drills. To allow easy adjustment of the large work for which the machine is intended, the work table may be adjusted lengthwise or rotated to bring the work into position for drilling.



A German Machine for Heavy Drilling with High Speed Steels.

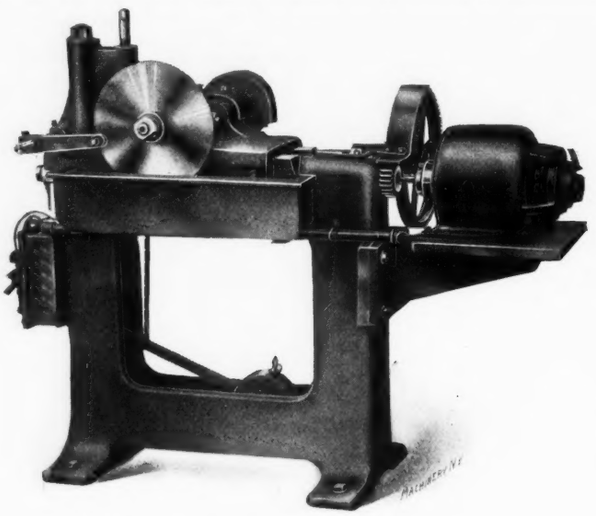
As may be seen, power is conveyed to the spindle by an endless belt, running from the driving cone pulley at the rear end of the machine near the floor, over idlers to the pulley on the spindle. This insures smooth running at the highest speeds. The back gearing is located on the spindle below the driving pulley. It is entirely encased so that it may be run in an oil bath. The maximum spindle speed is 670 revolutions per minute, and ten changes are provided for. All the driving gears are made of steel or phosphor bronze. The diameter of the spindle journal in the sleeve is 4 inches. It is hardened and ground, and is balanced, together with the sleeve, in the usual way. The feed mechanism is driven from one of the guide pulleys. It has eight changes and an automatic stop.

The table may be rotated on the saddle by which it is carried, and may be adjusted in and out on the bed as well. These adjustments may be driven by power, for rapid setting, but can be made by hand as well for minute adjustment. The table is about 4 feet 7 inches in diameter. The distance from the center of the spindle to the column is 2 feet 1⅛ inch. The whole machine weighs about 28,600 pounds.

As an example of its capacity in actual service (not for short trials) a large German manufacturer, who was the first user of this machine, has made the following record in everyday work, day after day, using high speed drills; 12 holes, 1⅞ inch each in diameter, were drilled in wrought iron flanges, 2 15/16 inches thick, in one hour—that is to say, at the rate of 5 minutes per hole, including the time necessary for setting up the work.

BURR MOTOR-DRIVEN COLD SAW FOR SMALL WORK.

The photograph shows a new motor-driven cold saw, built by John T. Burr & Sons, 34 South 6th St., Brooklyn, N. Y. It is adapted to the cutting off of stock, pipe, etc., up to 3½ inches in diameter. The saw-blade is 10 inches in diameter,



Burr Cold Saw arranged for Motor Drive.

and is fed by gravity, the pressure of the feed being adjustable by altering the position of the weight on the lever shown. The driving mechanism consists of a steel worm-gear, hobbed worm and steel pinions.

When arranged as shown, the machine is driven by a ½ horse-power constant speed motor, running at about 2,000 revolutions a minute. It is connected to the worm shaft by a rawhide pinion and a cut iron spur gear. All the gears are covered, and the starting box and switch are conveniently placed at the rear of the machine.

When desired, the makers will arrange the saw to be driven by an alternating motor.

GORTON CUTTING-OFF MACHINE.

Among the carefully designed and ingeniously constructed machines we are continually describing and illustrating in these columns, we once in a while have the opportunity to describe one which shows such striking originality of conception as to at once arrest the attention. This is the case with the cutting-off saw we here illustrate, built by the Geo. Gorton Machine Co. of Racine, Wis. The idea of turning the cutting-off saw "inside out" presents such obvious advantages that it is strange it has not been tried before. Very possibly it has been thought of; it would be strange if it has not been. But Mr. Gorton seems to have been among the first to think of it, and certainly the first to work the idea out in practical shape.

The difficulties met with in the design and operation of metal saws for heavy duty are well known. Fig. 2 shows the

conditions quite graphically. The saw is usually driven from a spur gear mounted on a saw arbor, which is of necessity very much smaller in diameter than the saw, to allow the latter to take a reasonable depth of cut. In the case shown, a not unreasonable one, the radius of the driving gear at the pitch line is only one-third of the radius on which the teeth

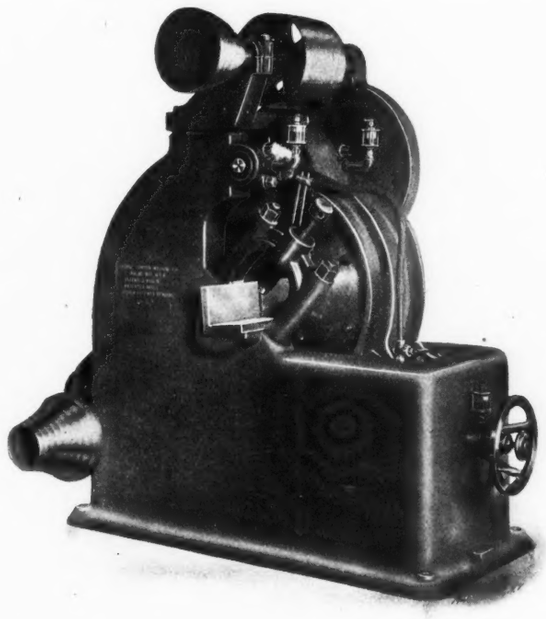


Fig. 1. The Gorton Cutting-off Machine, using Saw with Internal Teeth.

of the saw are cutting. This means that the driving power is lamentably weak, so that the consequent excessive vibration and chatter have established a limit in saw efficiency beyond which it has seemed impossible to pass. Various ingenious schemes have been tried for applying the power nearer the periphery of the blade, but in none of these, so far as we

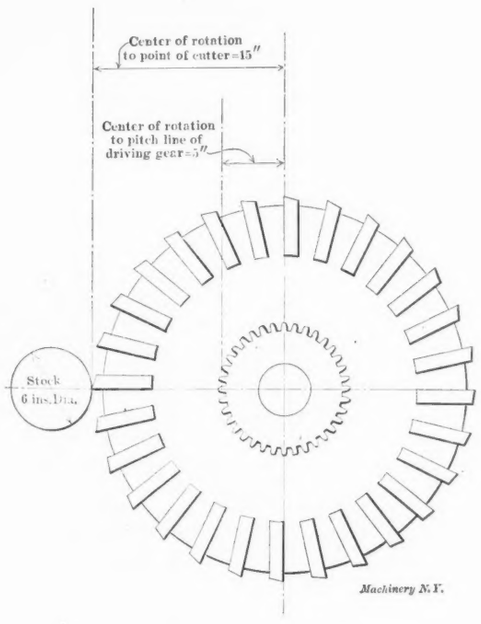


Fig. 2. The Usual Drive for Cutting-off Saw, applied to Small Diameter.

know, has it been possible to apply the power on a circle of greater diameter than that in which the saw blades revolve.

The mechanism by which this is made possible, is shown in Fig. 3. The saw, having inserted teeth of high speed steel, is mounted on a revolving ring and supported by a swinging frame, pivoted about the pinion shaft by which the ring and its attached saw are driven. The ring is journaled on its outside diameter in the swinging frame which carries it. The stock is passed through the center hole of the saw, and the saw is fed through the stock by swinging it about the center of the driving pinion, the frame for this purpose being provided with a 90-degree segment of a worm-gear, as shown, which engages the feed-worm below it. The ability to obtain a smooth and powerful drive by this means, and a smooth and powerful feed as well, will be readily appreciated.

Figs. 1, 4 and 5 show how the scheme of Fig. 3 has been applied in a commercial design. The frame of the machine, as may be seen, is of hollow, box-like construction, and exceedingly rigid. The main driving pulley (which is 14 inches in diameter by 10 inches face, and runs at 350 revolutions per minute) is connected by spur gearing with the driving pinion shaft, which is geared to the saw-carrying ring as described, and shown in Fig. 3. The swinging frame in which the ring and saw are mounted is shown raised in Fig. 4, and in working position in Fig. 1. The fact that this frame is hung on trunnions from above, avoids the possibility of having its bearings injured by grit and scale. This is an important detail in the construction of the machine, as is witnessed to by the badly cut ways frequently found on the usual types of sawing machines.

The driving pulley shaft is connected with the feed shaft at the rear of the machine, near the base, by a belt passing over a pair of six-step cones. These give six feeds in geometrical progression, which, on the 6-inch machine shown, will sever a 6-inch bar in from 1½ to 5½ minutes. As may be seen best in Fig. 5, this feed shaft is connected by worm-gearing in the enclosed casing shown, to a hollow shaft to which the feed worm is keyed. This shaft comes through to the front of the machine as may be seen in Figs. 1 and 4, where it may be operated by the large hand-wheel shown. The small hand-wheel controls a push-rod, which passes through the center of the hollow shaft and operates a clutch by which the worm-gear at the back of the machine is connected with the feed worm shaft. An automatic feed release is provided.

A geared lubricating pump is provided, with all the necessary piping, for conveying water or special lubricant to the

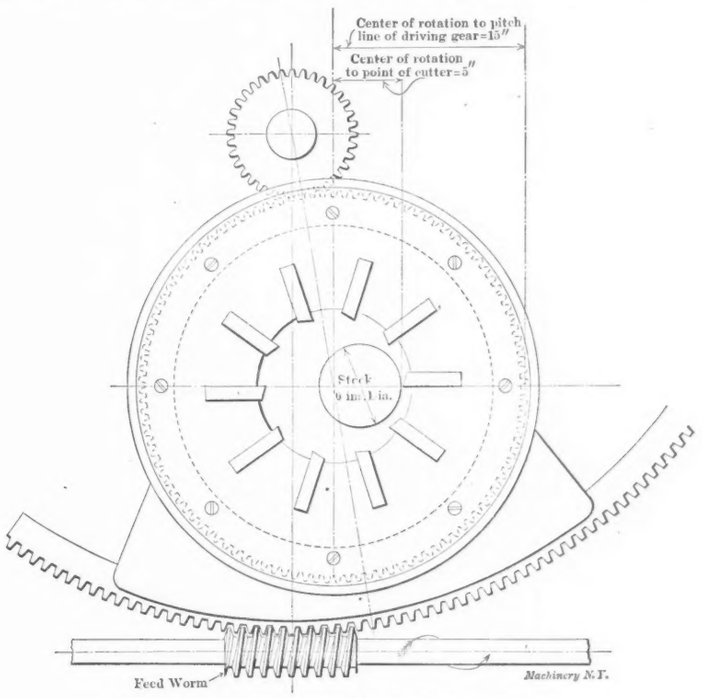

Center of rotation to pitch line of driving gear=15″
Center of rotation to point of cutter=5″
Steel 6 ins. Dia.
Feed Worm
Machinery N.Y.

Fig. 3. The Gorton Saw and Drive, giving Great Power.

cutting point. A generous reservoir is furnished by the base of the machine. An opening is provided at the rear (see Fig. 5) for the removal of the chips which settle into the chute shown, which is provided with a screen bottom, through which the lubricant drains off, while the chips slide down to the outside pan provided for them. This view also shows the adjustable gage, which may be used when desired, or swung

out of the way when not required. The rear stock support, as shown, enters the saw-driving ring close to the blade. Stock supports are furnished when desired, provided with rollers to enable heavy bar stock to be easily inserted and adjusted.

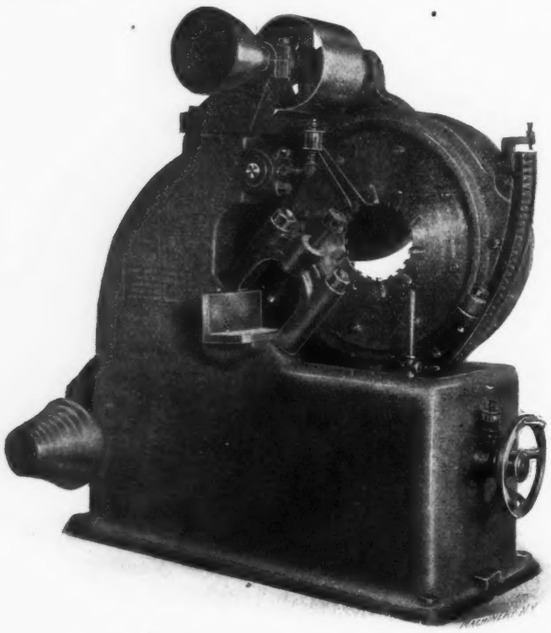


Fig. 4. The Machine with the Saw Frame Raised.

Special effort has been made to produce a machine capable of hard service through a long life, and one that it would be safe to trust to the care of unskilled operators. The gears are of generous proportions, and are all cut from the solid. The main driving pinion is a steel forging, formed integrally with the shaft. All the bearings either run in oil, are ring oiling, or are provided with sight-feed lubricators.

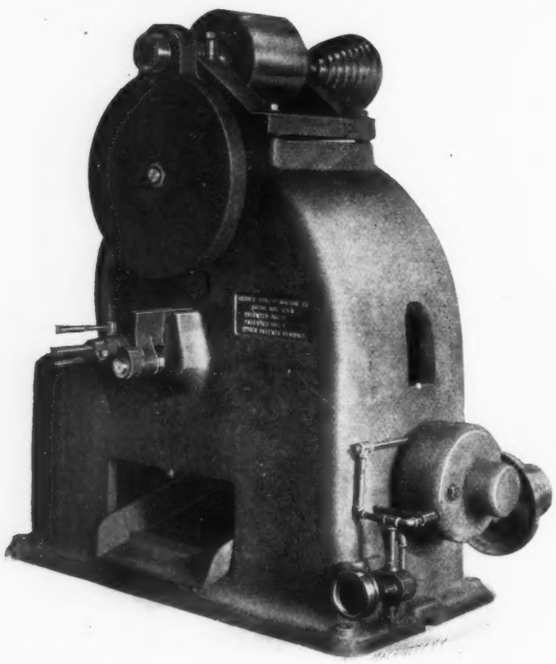


Fig. 5. Rear View of Machine, showing Feed Works, Chip Chute, Etc.

All these bearings are grit proof, and all the gears are fully enclosed. The feed worm is of generous size and runs continuously in oil.

Summarizing the advantages of this construction, we may say that the drive is from four to six times as powerful as on other machines of similar size; the feed is applied in a more effective manner, having as it does a 2 to 1 leverage; the saw blade works to better advantage, being supported around its entire periphery, so that it cannot buckle or "snake"; the machine is dust and grit proof throughout, and designed for operation by unskilled labor; and vibration and chattering is eliminated so that high saw speeds and heavy feeds are obtained.

We show an example of the work of the machine in Fig. 6. This shows a section cut from a 6-inch bar of open-hearth steel, with the saw feeding at the rate of 4 inches per minute, severing the 6-inch bar in a little less than 1½ minute. While doing this, it is said that the machine was entirely free from the slightest vibration. This was done on the machine we illustrate, which weighs about 7,000 pounds. The saw teeth cut at about 75 feet per minute, and were flooded with a compound of water, lard oil, soda, and soap. The power required for this maximum output is about 18 horse-power.

While this machine is a new one so far as being placed on the market is concerned, the idea is not a new one with Mr. Gorton, the designer; the main features of the machine have been a pet hobby with him for over twenty years. It has only been possible, however, to practically apply the principle in the last few years, since the advent of the high-speed steels, because the solid saw blades of the old type could be driven to their full capacity by the driving mechanism formerly in use.

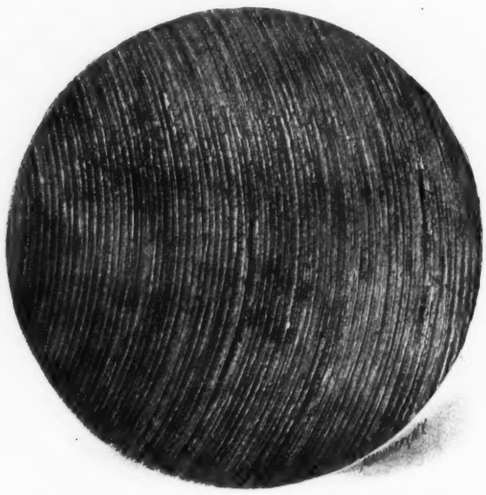


Fig. 6. This Section of 6-inch Open-hearth Steel was cut off in 1 1-2 minute, 75 feet per minute Cutting Speed.

The new steels plainly taxed the old design beyond its strength, and offered an opportunity for the practical application of the idea of an internal cutting-off saw.

In addition to the 6-inch size shown, three other sizes are in process of construction, these being for 4-inch, 9-inch, and 12½-inch stock, respectively. These machines weigh from 5,000 to 25,000 pounds each. They can be furnished either belt driven, or direct connected with an electric motor.

* * *

We have mentioned in the columns of MACHINERY, at various times, the proposed schemes for internal waterways in this country. Great as has been our railway development, we have, to a great extent, neglected the development of canals and inland waterways, which in Europe play so great a part in commerce and industry, supplementing the railways for such classes of freight as can be carried to advantage on the canals. The Inland Waterways Commission has now made a proposal to construct a vast system of canals, and to try to improve certain river channels, so that large craft may be able to use them, and an effort will be made to secure from the present Congress the necessary legislation for beginning the work. The most important of these proposals seems to be the construction of a deep waterway between the Great Lakes and the Gulf, but a number of otner projects are also under consideration. It is likely that some of the railroads will oppose this work, but in view of the difficulty of the railroads in handling the traffic of the country in prosperous times, it does not seem reasonable that there should be any objections from these quarters.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

Though in some industries in this country a comparative depression is evident, the trade of the country as a whole would appear in a more healthy state than that of any other. However, in the engineering and machine building industries a great many discharges are taking place. It is not that so many less machines are employed than during last year, but in place of being worked night and day, they are working day shifts or moderate overtime only. From one large machine building firm in Nottingham about 800 men have been discharged during the last three months, but for a year or two previously such continuous pressure on the productive capacity had never before been experienced, the whole plant having been working night and day. Then again, the question of unemployment generally is much more closely looked into than formerly. The unemployed making their plight known in no uncertain fashion, so that a depression or slackness which would have been taken as a matter of course in former periods, now, at once, receives recognition, and pertinent inquiries are made as to the causes leading up to it, and the best remedy to be employed. Of course such a state of things gives plenty of opportunity for divergence of views regarding tariff "reform," free trade, etc. At the moment, in the case of the Amalgamated Society of Engineers—the leading trades union in its line—the number of members receiving out-of-work pay is 4,863, and in the Boiler Makers and Iron Shipbuilders' Society 5,916 are similarly placed, a proportion of the membership giving cause for apprehension. However, the outlook is not altogether depressing. It is the contrast of ordinary, or somewhat restricted, working with what was perhaps a somewhat unhealthy pressure which makes things appear worse than the facts warrant.

Speaking on January 25, after inspecting the Cardiff Docks and the Great Dowlais Ironworks, Mr. Lloyd-George (president of the Board of Trade) addressing the members of the Exchange, said "There are just a few indications that the ebb tide in trade is beginning," but his opinion, based on the investigations of the best intelligence department in the empire—the Board of Trade—was, that they were not going to have a bad ebb tide. They had seen times of great prosperity. British exports last year attained dimensions of which neither this country nor any other had ever before seen the like. They must not forget that the present depression started in America, it was being felt in Germany, "and," he added, "our turn will possibly come, but it is not going to be a bad one from what I hear."

Results of New Patent Act.

Again, the new patent act, though it only came into force on January 1, is already bearing fruit. According to Mr. Ivan Levenstein, a prominent Manchester chemical manufacturer who took an active part in the agitation leading to the new act, a number of foreign patentees have been, and are, negotiating with British manufacturers to carry on, in the United Kingdom, their British patents, whilst others have taken land for the purpose of erecting works in order to work their British monopoly. As an instance may be mentioned the Hœchst Farbwerke, working in conjunction with Cassella & Co. The combined capital is valued at $40,000,000. They have secured land near Chester for a large works to be employed in the manufacture of synthetic indigo. Another concern, the Elberfeld Farbenfabriken, together with the Badische Aniline and Soda Works and the Berlin Co., with a capital of $65,000,000, are about to erect works, probably near Manchester. A well-known American firm holding British patents for the manufacture of safety razors, hitherto made solely in the States, is reported to have secured land in Sheffield, and expect to employ about 500 men. According to Mr. Levenstein, "Scores of the foreign manufacturers holding British patents which they have previously worked solely abroad, are following their example, and there is not the slightest doubt that the new act will find additional employment for our people, the operative classes, highly trained engineers, and chemists, and give a new impetus to British enterprise. This will become more and more apparent as time goes on. Fortunately, the act, unlike preceding ones, is so definitely and clearly worded—especially is this the case with Section 27, which deals with the revocation of patents worked outside the United Kingdom—that there are no loopholes to afford escape from it. Surely Mr. Lloyd-George must feel proud of having passed such a far-reaching measure, an act that will confer greater benefits on our industrial welfare than any act passed during the last fifty years."

Labor Union Topics.

For some little time Mr. Lloyd-George has appeared all-pervading, in the facilitation of trading operations, and, more recently, in the influence he has exercised in the settlement of industrial disputes of unprecedented magnitude. Following on the railway men's dispute came that of the cotton spinners respecting revisions of piece-work price lists, which involved most complicated details and numerous side issues. A very reasonable solution was arrived at through Mr. Lloyd-George's direct intervention, and replying to the thanks accorded him he congratulated both parties very heartily on the splendid good sense and good feeling they had shown. He thought it was a real victory for British industry, and he felt that as long as British industry was conducted on both sides by men who were capable of settling disputes in that way, they had nothing to fear from rivals in any part of the world. Hardly was this particular dispute settled, when another broke out respecting the wages of female labor in another section of the trade—ring spinning. Though the number of workpeople primarily affected was small, a lock-out of the whole number employed which would, directly and indirectly, throw 250,000 people out of employment, was threatened. Finally, an eleventh-hour dramatic settlement was reached late in the afternoon of January 24, the day previous to the expiration of the lock-out notices.

Ship-building Notes.

Though last year closed unpropitiously as regards shipbuilding, the aggregate tonnage for the year was phenomenal. On the Clyde 509 ships were launched of a total tonnage of 620,000 tons as against 372 ships of 599,000 tons in 1906. Eleven years ago the highest total was 400,000 tons, and six years ago, 500,000 tons. Yarrows', the well-known torpedo vessel builders, are now practically removed from London to the Clyde. After one or two torpedo boats, now almost completed, are handed over, all business will cease at the old works. Some reduction in the rate of warship building was anticipated last year, but the new German program has necessitated a revision of the British scheme, so that busier times than the present are anticipated during the year in the warship building centers. Refrigerating machinery will, in the future, be much more extensively employed than in the past for cooling ammunition chambers in the navy, recent explosions in the French navy emphasizing its importance.

The manner in which the United States engineering corps is proceeding with the construction of the Panama Canal occasions commendatory notice over here. The fact that the United States government eventually lost patience with the propositions placed before it by commercial interests, and found it necessary to directly proceed with the work, appears rather a "nasty jar" for private enterprise, which is usually understood to be ahead of government managed concerns. The American consul at Sheffield reports a big decrease in the exports of special steel, for mining purposes, to the United States. For the last quarter in 1907, only $109,344 worth of this steel was exported to that market as against $736,970 the previous quarter, $810,895 six months before, and $783,075 a year previously.

Condition of Textile Machinery Trade.

The textile machinists still make a very good show in the matter of exports, the returns showing continued increases. For November the figures are $3,572,890 as against $3,057,105 for the same period in 1906. For the first eleven months of 1907 the figures were $36,723,665, against $30,396,505 in the corresponding months of the previous year. The increases have been mainly in spinning, as distinct from weaving machinery. It does not pass unnoticed that the export of machinery increases the competition to be faced by British

textile manufacturers, but the machinists, of course, cannot help that, and it is significant that the present year has been a record one for Lancashire spinners of American cotton, the profits being nearly double those of 1906. Taking the returns of one hundred mills, a share capital of $18,613,900 has earned no less than 35½ per cent net profit, an increase of 18 per cent. The total capital employed includes $11,887,330 loaned capital in mortgages, debentures, and short date loans, and taking it that 4 per cent has been paid on these loans, the total profit on the combined share and loan capital works out at about 23 per cent. These returns do not apply solely to new mills, but include some which have been in existence over thirty years. With increasing production and uncertainties in the supply of raw material and labor disputes, such unusually good returns are not anticipated during the coming year. While touching on these cotton trade matters—which have a more intimate connection with engineering and machine building prospects than is generally recognized—an important inquiry is being made by the British government as to the pros and cons of the practice of "steaming" or introduction of artificial humidity in weaving sheds, as regards its effects on the health of workpeople. The commission is very representative, and includes Sir Hamilton Freer-Smith, superintendent inspector of factories; Mr. J. D. Shackleton, M. P., and Mr. Joseph Cross, on behalf of the workpeople; Mr. Henry Higson and Mr. J. Roberts, for the employers, and Prof. Lorraine Smith, M.D., professor of pathology at Victoria University.

Machine Tools.

The use of disk grinding machines, mostly of British make, is spreading in this country, though the tendency seems in the direction of an increase in the range of quality, capacity, and adaptability. Many of the more expensive machines are fitted with accurate attachments, but the requirements of users who appreciate the advantages of this method of working, but have no need for continuous working of a machine or the acme of refinement, are now also receiving attention, and a number of reasonably well-made and durable machines are now obtainable at a very moderate cost. Tool grinding emery wheel machines are also developing on much the same lines: Arrangements for supplying the necessary water spray in a convenient manner, and also the provision of cheap and easily handled wheel truers, being well attended to. Richard Cremer, Aire Road, Leeds, is now supplying a handy range of clamps and divided machine vices, etc., of varying designs from those for holding constructional steel work whilst being drilled, etc., and those with one jaw of the clamp having a semi-globular grip enabling it to clamp work of varying tapers, to cheap, quick acting clamps for carpenters and cabinetmakers' work. Very satisfactory sales are reported.

In Germany, the Union of Iron and Steel Industries, in conference, mentions the possibility of the smaller industries syndicating in defense, in consequence of the action of large industrial syndicates. It was therefore necessary to bring about an agreement in time. Also, "perhaps the financial power and the intellectual training of Germany had been overestimated." In conclusion, the extent to which the British industrial classes, notwithstanding occasional accusations of improvidence, assure against sickness, and death, may be mentioned. In a recent government report, one society alone, the Manchester Unity of Odd Fellows, is shown to have an available capital of $66,851,345, and a number of others are proportionately well placed, and in the case of other societies which, through lack of actual data at the time of their inception, have been rather severely tested for some years, are now making very good progress in the right direction.

Importance of Machine Tool Business being More Recognized by European Engineering Journals.

A tendency recently more noticeable over here is the increasing attention given in the engineering journals to machine tool matters. It is evidently being grasped that improvements in design and manipulation are now made so rapidly that special effort is needed to chronicle them in such a form and with such promptitude as will make them of value to readers. JAMES VOSE.

Manchester, England, February 10, 1908.

MISCELLANEOUS FOREIGN NOTES.

EXHIBITION OF APPLICATIONS OF ELECTRICITY IN MARSEILLES.—An exhibition devoted to the application of electricity in the arts and industries will take place next summer in Marseilles, France, commencing on April 19, and closing on October 31. The exhibition is intended to be of international scope. Applications for sites should be sent to, and further information may be had from, the Commissariat-General, Boulevard Louis Salvator, 52, Marseilles, France.

AUTOMOBILE INDUSTRY IN GERMANY.—We have previously referred to the fact that the present reaction in the automobile industry has not affected German manufacturers as badly as those of the other three great industrial nations. One reason for this appears to be that a large proportion of the motor car builders in Germany are also engaged in some other line of manufacture, such as that of bicycles, sewing machines, typewriters, or even machine tools, and thus are able to concentrate their activities on their other industries when one declines.

AUSTRIAN TRADE CONDITIONS.—While it is stated that the condition of the iron and steel and allied industries in Austria is not on as favorable a basis as a year ago, there does not seem, from present reports, to be any serious cause for complaints. There are delays in deliveries, charged partly to scarcity of labor, but that is rather a sign of continued prosperity than the reverse. The true state of affairs may be that the financial flurry in the United States reacted throughout the world, causing a temporary depression, but not in any way unsettling business conditions.

DEPRESSION IN THE BRITISH SHIPBUILDING TRADE.—Continued depression in the shipbuilding trade in the northern portion of Great Britain is reported. Employers have been forced to issue the usual three months' notice that demands a reduction in wages of 5 per cent on piece work, and 2 shillings a week on time rates, this latter also being equivalent to a reduction of about 5 per cent, or perhaps a somewhat greater amount, of the wages paid. It is stated that the ship yards at present have plenty of work on hand, but that the orders for new work are not coming in to such an extent as to make the future prospects as bright as would be desirable.

THE JAPANESE EXHIBITION OF 1912.—The Exhibition Committee of what is termed the Grand Exhibition of Japan, which will be opened in Tokio, on April 1, 1912, has given out a statement in regard to the general rules governing the exposition. Foreign exhibits belonging to the five departments of education, science, machinery, electricity, and manufactured goods, will be allotted space in the exhibition buildings, specially erected for these departments. For exhibits other than those above mentioned, any nation may have a separate building, erected at its own expense, but no charge will be made for the space allotted for such buildings. Machines and articles imported from foreign countries for the sole purpose of exhibition will be admitted free of duty. It is also intended to afford special protection to all inventions, designs and models of foreign exhibits, and a bill to that effect will be introduced at the next session of the Japanese Diet. The site of the exhibition covers about 292 acres.

MACHINE TOOL TRADE IN GERMANY AND ENGLAND.—As time progresses it appears that the same reaction as has taken place in the steel industry in this country has also made itself apparent in Germany. There is a stringency of money, which is rather unusual, tending to prohibit the entering into new enterprises, and preventing the ordinary commerce from being carried on as usual. The conditions in the machine tool trade, itself, however, seem promising. In England, also, the latest information indicates steady conditions, and the outlook for new business does not seem unsatisfactory. Extensions of works are still carried on to a great extent, and the modernizing of shop equipment creates a great demand for machine tools. As the home market in this country is not placing as heavy demands on our manufacturers as usual, it is likely that they will be able to secure for themselves a share of this trade in Great Britain.

THE AUTOMOBILE INDUSTRY ABROAD.—Recent reports indicate that the automobile industry in Great Britain and Germany is placed on firm ground, while the manufacture of motor cars

in France is not in the same flourishing state as in the years past. The explanation of this condition, partly at least, is doubtless to be found in the fact that many French firms have devoted themselves exclusively to expensive pleasure vehicles, the demand for which is rapidly waning, while the German, and, particularly, the English makers have devoted themselves also to the development of cars for industrial purposes, and cheaper cars for everyday use in business, for which latter classes of motor cars the demand is increasing. The exports of British cars is steadily increasing. During the first eight months of this year these exports amounted to a value of $2,380,000 as compared with $1,200,000 for the same period the preceding year. At the same time imports of foreign cars to Great Britain have been decidedly smaller than last year. In France, while an increase of production is reported, several failures of automobile building firms are also on record. Thus, the Société Automoto in Saint Etienne, Loire, with a capital stock of 1,700,000 francs, has ceased payments, and a receiver has been appointed for the Pilain firm in Lyons, which has a capital of 1,500,000 francs. The figures stating the extent of Germany's motor trade for the six months ending June 30, 1907, indicate that Germany is still importing a greater number of cars than it exports, the imports being valued at about $2,900,000, while the exports were valued only at about $1,800,000, or less than two-thirds of the imports. It is a significant fact, however, that one-third of the exports were industrial vehicles, which rather confirms one of our previously made assertions that Germany is placed on a firmer basis in the automobile trade on account of having devoted more energy to industrial vehicle than to pleasure cars.

* * *

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.

The National Society for the Promotion of Industrial Education held a three days' meeting at the Art Institute, Chicago, Ill., January 23-25. A public dinner was given at the Auditorium Hotel, January 23, of which Mr. Theodore W. Robinson, first vice-president of the Illinois Steel Co., was toastmaster. Papers on industrial education as an essential factor in our national prosperity, were presented by Dr. Chas. W. Elliott, president of Harvard University, and Mr. James W. Van Cleave, president of the National Association of Manufacturers, St. Louis, Mo. Dr. Pritchett spoke on the aims of the National Society for the Promotion of Industrial Education. At the public meetings of January 24 and 25 a number of notable papers were presented on various phases of industrial education, apprenticeship, etc. Among these were "The Apprenticeship System as the means of Promoting Industrial Efficiency," by Carroll D. Wright, Worcester, Mass. The list of speakers included men and women prominent in industrial education, among whom were Mr. W. R. Warner, Cleveland, Ohio, of the Warner & Swasey Co.; Mr. James O'Connell, Washington, D. C., president of the International Association of Machinists; Mr. J. F. Deems, general superintendent motive power, New York Central lines; Mr. Leslie W. Miller, Philadelphia, Pa., principal Pennsylvania School of Industrial Art; Miss Jane Addams, of Hull House, Chicago, and many others whose names are prominently connected with industrial betterment.

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THE VALUE OF A TREATISE AS AN ADVERTISING MEDIUM.

About eight years ago a series of articles on mechanical draft by Walter B. Snow was published in MACHINERY, which attracted wide attention. These articles were afterward published in book form by the B. F. Sturtevant Co. with the title "Mechanical Draft," for which a nominal price of $1.50 was charged. The price, however, was a device to prevent needless distribution to a class that could make no good use of such a work. It was distributed free to concerns, engineers and others legitimately interested in the subject of mechanical draft.

Mr. Snow, the author of the work, published an article in the November issue of *Selling Magazine*, in which he referred to the extraordinary advertising value of such a work. The work on mechanical draft treated the subject in a comprehensive manner, giving rules, tables, and formulas of much value to the engineering profession. The fact that the book is essentially an argument for mechanical draft does not necessarily detract from its value as a contribution to engineering literature. Engineers who received a copy were only too glad to make it a part of their engineering library, where it became a source of information and an educational influence in favor of the use of the fan as a substitute for the high brick chimney.

The hint is one that is worth taking to heart by manufacturing concerns who spend large sums on their advertising literature. It is not enough that the best cuts, finest paper and elegant press-work be used in advertising literature. If the literature does not contain something of permanent value it will not be retained by the recipient, unless it is made part of a catalogue file. There are catalogues, however, of very ordinary appearance, but containing valuable tables and data pertaining to the subject matter in general which are treasured and frequently referred to. There is undoubtedly a wide field for the expansion of this idea. Many lines of work could be represented by catalogues which would be in effect, condensed treatises of great value on the subjects represented. Such advertising matter is not ephemeral but becomes more and more valuable with the years.

* * *

A remarkable test of endurance of automobiles was begun February 12 when six automobiles left Times Square, New York, for Paris, France. The route is across the United States to San Francisco, thence by water to Valdez, Alaska, thence by land to Cape Prince of Wales *via* Nome, thence across Behring Strait to Siberia, thence by land to Paris. The total distance is about 22,000 miles. The cars entering the race were Thomas (American), De Dion (French), Moto-Bloc (French), Sizaire-Naudin (French), Zust (Italian), Protos (German). The Sizaire-Naudin car broke down twice in traveling the first 100 miles and withdrew from the race.

* * *

PERSONAL.

W. P. F. Ayer, who has represented the Walworth Mfg. Co., Boston, Mass., for many years in the South, has been appointed assistant secretary of the company.

H. H. Vreeland, president of the New York Railroad Club, and a well-known street railway man, was the guest of honor at a dinner given by the club at the Hoffman House, February 7.

Arthur W. Graham, of the Builders' Iron Foundry, Providence, R. I., sailed January 25 for an extended trip to Mediterranean ports and other places of interest in Southern and Western Europe.

Robert McF. Doble, consulting engineer making a specialty of hydro-electric power equipment and transmission, formerly of San Francisco, California, has removed his office from Colorado Springs to No. 528 Majestic Bldg., Denver, Colorado.

L. R. Pomeroy, a well-known railway shop equipment engineer, has resigned his position with the General Electric Co., to become assistant to the president of the Safety Car Heating and Lighting Co. He will have charge of the sales department.

Lester G. French, formerly editor of MACHINERY, and later manager of the Technical Press, Brattleboro, Vt., has been made editor of the Proceedings of the American Society of Mechanical Engineers, New York. Mr. French assumed his new duties March 1.

Charles A. Bacmeister has been appointed western representative of the Monarch Emery & Corundum Wheel Co., Camden, N. J., with headquarters in Chicago. Mr. Bacmeister has had extensive experience in the grinding wheel business, and is well prepared to fill his new position.

C. F. Harding has been appointed head of the school of electrical engineering, Purdue University. Prof. Harding is a graduate of the Worcester Polytechnic Institute. He has a broad practical training as an engineering teacher, and special training along the line of high tension railway work. He was electrical engineer for the first electric railway built in New England. He was engineer for the D. & W. Fuse Co.,

Providence, R. I., publication manager for the Fort Wayne Electric Co., Fort Wayne, Ind., and engineering expert for Stone & Webster, Boston, Mass. He was also associate professor of electrical engineering of Cornell University. Prof. Harding will assume his new duties about March 1.

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OBITUARY.

Daniel Shafer, for the past three years salesman and engineer with the Allis-Chalmers Co., died of pneumonia January 24 at Nashville, Tenn., aged 47. His home was in Wheeling, W. Va. Mr. Shafer was well known and had a wide circle of friends. Prior to taking his present position he was associated with Hooven-Owens-Rentschler Co., Hamilton, Ohio.

Orrin S. Werntz, treasurer of the National-Acme Mfg. Co., Cleveland, Ohio, since its organization, died February 6, 1908, after an illness of about one month. He was born in Canal Fulton, Ohio, and was thirty-two years old. His first position was with the National Screw & Tap Co., which he retained until the organization of the National-Acme Mfg. Co. He is survived by his wife, mother and young son.

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NEW BOOKS AND PAMPHLETS.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING TO THE SECRETARY OF THE NAVY FOR 1907. 56 pages, 6 x 9 inches. Published by the Navy Department, Washington, D. C.

A COMPARISON OF THE EFFECTS OF FREQUENCY ON THE LIGHT OF INCANDESCENT AND NERNST LAMPS. By Frederick W. Huels. 45 pages, 6 x 9 inches. Published by the University of Wisconsin as Bulletin 157. Price 25 cents.

TESTS OF PLAIN AND REINFORCED CONCRETE, Series of 1906. By Morton Owen Withey. 66 pages, 6 x 9 inches. Illustrated. Published by the University of Wisconsin, Madison, Wis., as Bulletin No. 175. Price 25 cents.

EXPERIMENTAL WORK CONDUCTED IN THE CHEMICAL LABORATORY OF THE UNITED STATES FUEL TESTING PLANT, St. Louis, Mo., January 1, 1905, to July 31, 1906. By N. W. Lord. 52 pages, 6 x 9 inches. Published by the U. S. Government, Washington, D. C., Department of Interior, U. S. Geological Survey.

This is Bulletin 323 and is devoted to an account of experimental work conducted on coals.

INVESTIGATION OF CENTRIFUGAL PUMPS. By Clinton Brown. 140 pages. 6 x 9 inches. Published by the University of Wisconsin as Bulletin 173. Price 50 cents.

This bulletin is devoted to a discussion of the theory of the centrifugal pump, and a record of tests of a 6-inch vertical centrifugal pump. It includes a description of the pump and impellers, general method of making observations, calibration of electrical instruments, effect of the number of vanes and variation of speed on discharge and efficiency, effect of curving the vanes of the impeller at entrance, power required to hold up the head of impending delivery.

HOW TO READ PLANS. By Charles G. Peker. 46 pages, 4¾ x 7¼ inches. Illustrated with 43 cuts and 8 folding plates. Published by the Industrial Publication Co., New York. Price 50 cents.

Many carpenters are handicapped by ignorance of ordinary working drawings, and this little work is intended to instruct such mechanics in the principles of working drawings so that any intelligent mechanic will be able to work from drawings intelligently. Incidentally the book will be found useful by carpenters who desire to make drawings or sketches of building details for themselves. The folding plates are of a six-room frame house and this set of plans alone is worth many times the cost of the book to the ambitous carpenter who would launch out in independent work.

A STUDY OF FOUR HUNDRED STEAMING TESTS MADE AT THE FUEL TESTING PLANT, St. Louis, Mo., in 1904-1905-1906. By L. G. Breckenridge. 200 pages, 6 x 9 inches. Illustrated. Published by the U. S. Government, Washington, D. C., Department of Interior, U. S. Geological Survey.

The fuel tests discussed in this publication were made under two Heine water-tube boilers by the U. S. Geological Survey Fuel Testing Plant at St. Louis, Mo. These boiler tests were begun during the Louisiana Purchase Exposition during 1903, and have been continued. The general information and results yielded by these boiler tests are of great value. The voluminous nature of the published reports makes the present study of much greater value to those who have not the time or ability to make an analysis of the previous publications.

TABLES OF THE PROPERTIES OF STEAM AND TEMPERATURE-ENTROPY TABLE. By Cecil H. Peabody. 131 pages, 6 x 9 inches. Published by John Wiley & Sons, New York. Price $1.00.

These valuable tables are too well-known by engineers to require an extended review. They were calculated about twenty years ago to accompany Prof. Peabody's work, "Thermodynamics of the Steam Engine." Since then they have been re-computed, and the results of important experimental investigations have been incorporated. The present edition is the seventh. The tables given are for steam, English units, degrees; steam, English units, pounds; steam, French and English units; ether; alcohol; chloroform; carbon-bisulphide; carbon-tetrachloride; aceton; ammonia; sulphur-dioxide; specific volumes of liquids; volumes of hot water; inches of mercury and pounds; connective factors, superheated steam, etc. The tables are presented in attractive typographical form and are indispensable to the testing engineer and others having to do with the calculations in thermodynamics.

STEAM TURBINES. By Carl C. Thomas. 334 pages, 6 x 9 inches. 145 illustrations and 20 large folding plates. Published by John Wiley & Sons, New York. Price $4.00.

This work has passed into the third edition. The development of steam turbines during the past few years has been very rapid, and the revised edition gives attention to the problems in design of the Curtis and Parsons types of turbines and to suggestions regarding turbine analysis. The book is written with a view of setting forth the principles essential for intelligent grasp of steam turbine work. It is to be recommended to designers, engineers and others having to do with the theory of steam turbine operation and construction. It discusses the general principles relating to the action of steam upon turbine buckets; thermodynamic principles involved in the flow of steam; calculation of velocity; the effect of frictional resistance on velocity; experimental work on the flow of steam through orifices, nozzles and turbine buckets; the impulse, and impulse and reaction turbines; the operation of various shapes of turbines. One chapter is devoted to marine steam turbines.

A STUDY OF ROOF TRUSSES. By N. Clifford Ricker. 28 pages, 6 x 9 inches. Illustrated. Published by the University of Illinois, Urbana, Ill.

This publication is Bulletin No. 16 of the series issued by the engineering experiment station of the university for free distribution, and is fully up to the high mark set by the previous bulletins. It records the results of several years' study and tests. About fifty trusses of a selected type and of different proportions and arrangement were designed in long-leaf pine and steel and changed until the assumed and actual weights of the trusses agreed. Other trusses were likewise designed in white pine and steel and a few entirely constructed of steel. To perform this work as conveniently and as rapidly and accurately as possible, it became necessary to devise simplified formulas and tables, with a systematic method of treatment, all of which are fully explained in the pamphlet. The results illustrated are mostly shown in graphic tables for ready appreciation. The most important features are a new formula for the weights of trusses; per cent of weight to be added for connections; most economical ratio of depth to span of truss; distance between trusses; number of purlins per panel; and dimensions of panels. It was found that white pine and steel trusses are about 10 per cent lighter than those of long-leaf pine and steel; also, that if carefully designed, steel trusses from 100 to 200-foot span have about the same weight as those of white pine and steel. It is believed that this bulletin will be valuable and suggestive to all persons interested in the design and construction of trussed roofs.

MEN WHO SELL THINGS. By Walter D. Moody. 295 pages, 6 x 9 inches. Published by A. C. McClurg & Co., Chicago, Ill. Price $1.00; by mail, $1.10.

Selling goods is an art that few master in the full sense of the term, but it is one which many may become proficient in, if we can accept the sentiments of the author. The masters of the art, if there be any, will not need to read this book to learn anything new, of course, but they will find it interesting, nevertheless, and perhaps helpful and uplifting in a moral sense. It was written by a veteran who worked his way from stock-boy to salesman, from salesman to buyer, from buyer to sales manager, and from sales manager to employer. It records the observations of over twenty years' experience in America and in Europe. The author denies that the trite expression "salesmen are born, not made" is unqualifiedly true. Failures or "near salesmen," as he calls them, are often such because of small faults or vices that could be and would be corrected if once they were recognized. The "near salesman" ordinarily does not recognize that he just misses being the "real thing," or if he does dimly see it he cannot see the cause for it. For such unfortunates this book, read in the right spirit, should be helpful, indeed. It is good for any one to read, being optimistic and moral in tone. It leaves no escape from the conclusion that strict integrity and uprightness of character are positively necessary to any salesman's success, in the long run. In fact the qualities requisite for success in a salesman are exactly those that are required in a merchant, banker, manufacturer or business man of any kind, salesmanship being not so very much different from any other business in the last analysis.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS. Written and compiled by a staff of specialists. 1,283 pages, 4 x 6¾ inches (standard handbook size). Numerous illustrations, diagrams and tables. Published by McGraw Publishing Co., 239 West 39th St., New York. Price, bound in flexible red morocco, $4.00

No doubt one of the best forms of technical literature for everyday use is the engineer's handbook as it exists in numerous examples. These convenient compilations bring together into one comparatively small volume the equivalent of many books in their essentials, and when, as in this case, a copious index with cross references is provided, the comparative value of such aids to rapid work is beyond computation. This work is unique in that it is, in effect, twenty handbooks in one, there being twenty chapters or units on various subjects, each prepared by an expert in the subject treated. It contains about one million words, 1,300 illustrations, and the index has over 6,000 references. The mechanical and typographical features are exceptionally good. It is printed on India bible paper, 1,300-odd pages of which are only about 1¼ inch thick. The binding permits the book to lie flat open at any page without breaking down the back. Following are the headings of the sections: Units; Electric and Magnetic Circuits; Measurements and Measuring Apparatus; Properties of Materials; Magnets; Transformers; Electric Generators; Electric Motors; Batteries; Central Stations; Transmission and Distribution; Illumination; Electric Traction; Electrochemistry; Telephony; Telegraphy; Miscellaneous Applications; Wiring; Standardization Rules; Tables and Statistics. The handbook is one that can be heartily recommended to the electrical engineer and his brother the mechanical engineer, who, more and more every day, has to undertake work involving knowledge of things electrical.

CATALOGUES AND CIRCULARS.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 64, "Locomotives Built for the Central Railway of Brazil."

CULLMAN WHEEL CO., 1019 Dunning St., Chicago, Ill. Catalogue No. 6 of driving chain, sprockets, automobile differential gears, etc.

GREEN FUEL ECONOMIZER CO., Matteawan, N. Y. Bulletin No. 148 on mechanical draft illustrating, and describing the Green apparatus and applications.

BROWN & SHARPE MFG. CO., Providence, R. I. Booklet entitled: "Why the Constant Speed Drive Milling Machine," giving reasons why constant speed drive is preferable to the cone drive.

GISHOLT MACHINE CO., Madison, Wis. Loose leaf illustrating boring automobile cylinders on the Gisholt turret lathe, and a view in the Warren, Pa., shops.

WHITMAN & BARNES MFG. CO., Chicago, Ill. Catalogue No. 66 listing "Diamond" twist drills, reamers, screw wrenches, drop-forged wrenches, spring cotters, etc.

JENKINS BROS., 71 John St., New York. Supplement to 1907 catalogue superseding pages 70-71, and giving description and list prices of Jenkins Bros. extra heavy and medium pressure gate valves.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Twelve-page booklet descriptive of graphite brushes for motors and generators. Useful information of those having electrical apparatus in care is given.

WHITMAN & BARNES MFG. CO., Chicago, Ill. Circular descriptive of the "Norka" high-speed twist drills, "Economy" high-speed flat drills, "Economy" chucks for flat drills and "Norka" chucks for Norka twist drills.

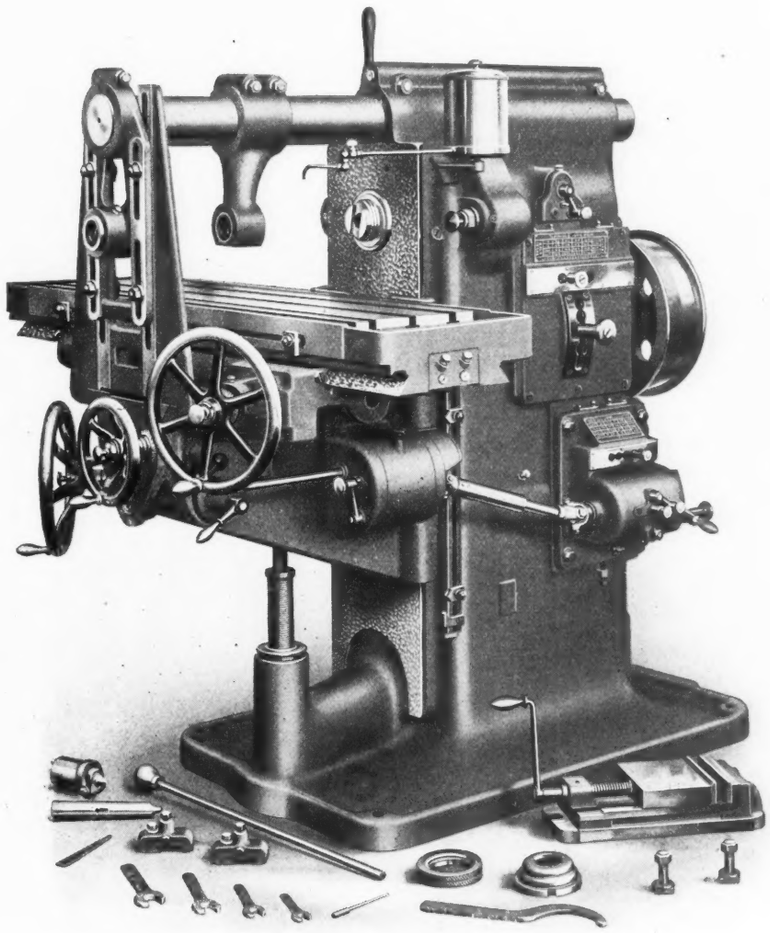
DE LAVAL STEAM TURBINE CO., Trenton, N. J. Bulletin 501, being a catalogue of turbine steam engines for driving dynamos, blowers and centrifugal pumps, and of electric motor pumps, multi-stage pumps, steel plate and cast-iron foundry blowers, etc.

BOSTON GEAR WORKS, Norfolk Downs (near Boston), Mass. Catalogue EI of gears, chains, sprockets, bearings, automobile steering devices, etc. It will be found of general interest to mechanics, model-makers and others having use for gearing.

LUCAS MACHINE TOOL CO., Cleveland, Ohio. Flyer entitled "Matthew Mears and His Eight-day Clock," *but* advertising the Lucas power

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.



PRACTICAL ECONOMY

in milling machine buying is demonstrated when the purchaser insists that the

Workmanship of the new machine shall be of the Highest Order,

Production shall be greater than that of a machine of earlier design, and

Quality and Accuracy in the finished product shall be maintained.

AN EXAMINATION OF B. & S. MILLING MACHINES AND THEIR FEATURES WILL SHOW THAT THEY EMBRACE THE ABOVE POINTS.

forcing press. To properly sympathize with Matthew one must read the heart-rending verse by "Unknown Poet."

ROCKWELL ENGINEERING CO., 26 Cortlandt St., New York. Leaflet descriptive of the Rockwell portable oil heaters for boiler shops, railway shops, foundries and wherever it is required to heat parts that cannot be readily transported to a stationary furnace.

GEM MANUFACTURING CO., Spruce St., near 33d St., Pittsburg, Pa. Bulletins Nos. 3 and 4 on "Gem" bench oilers, heavy mill oilers, torches, oil carriers, tallow pots, flue scrapers, foundry chaplets, loose pulley lubricants, flexible shafting, portable grinders, center grinders, polishing machines, universal joints, etc.

LEKTRO MFG. CO., 44 Walnut St., Cincinnati, Ohio. Pamphlet descriptive of the "Lektro" portable universal grinder which was illustrated in our January issue. The pamphlet is illustrated with a number of views showing the large number of applications possible with the grinder.

WESTERN ELECTRIC CO., Hawthorne, Ill., has issued a bulletin describing the Beck flaming arc lamp with data covering its performance. These lamps are made for either direct or alternating-current, and have been so simplified in construction as to require little skilled attendance.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Pamphlet entitled "Shop Instructions for the Use of Thermit in Repair Work," which will be found a valuable instructor in thermit repair work. It illustrates the crucibles, fire-brick molds, methods of preparing the fractured part for welding, etc.

UNITED ENGINEERING & FOUNDRY CO., Pittsburg, Pa. Catalogue of shears of the lever and vertical type. A large variety of styles are shown, including the most powerful lever shear ever built. This machine has a capacity of 6½ x 6½ inches of cold soft steel, and weighs 171,000 pounds with the steam engine driving it.

CARPENTER STEEL CO., Reading, Pa. Pamphlet descriptive of special steels for automobiles made by the company, including chrome-nickel steels, nickel steels and carbon steels. This pamphlet will be found of much interest to users of high-grade steels. It gives tables of tests, characteristic curves, and other data showing to what refinement the manufacture of alloy steels has been carried in America.

STANDARD STEEL WORKS CO., Philadelphia, Pa. Catalogue of springs for railway and electric traction service. The plant of the company is situated at Burnham, Pa., where the manufacture of steel springs was removed in 1903, the business having been begun in 1871 at the Philadelphia plant of the Baldwin Locomotive Works. The equipment for the manufacture of railway springs is very complete and extensive.

PARK DROP FORGE CO., Cleveland, Ohio. "Short Stories About Steel." Nos. 1 and 2. The first pamphlet gives a brief account of the early history of iron making in England, and the second is on Dud Dudley and the invention of smelting iron with coal. The pamphlets also contain useful information on all kinds of steel used in drop forgings and the common elements found in steel.

UNION PACIFIC RY., Omaha Shops, Omaha, Neb. Pamphlet descriptive of the gasoline motor passenger cars for suburban traffic developed under the direction of Mr. W. R. McKeen, superintendent of motive power. The latest cars are Nos. 10, 11, 12 and 13 placed in service at Denver, Col. These cars have six-cylinder motors of 200 normal horse-power and run at 60 to 70 miles per hour.

UNION PETROLEUM CO., Philadelphia, Pa. Pamphlet containing extract from report of the Commissioner of Corporations, Department of Commerce and Labor, on the petroleum industry, which gives an interesting account of the experience of an independent oil refiner in attempting to sell lubricating oils to the Norfolk & Western Ry. in competition with the Standard Oil Co.

EBERHARDT BROS. MACHINE CO., 66 Union St., Newark, N. J. Illustrated descriptive circulars Nos. 2A and 3 of automatic spur gear cutting machines. No. 2A has a capacity up to 27 inches diameter, 8 inches face, 6 diametral pitch. The capacity of No. 3 machine is 36 inches diameter, 10 inches face and 4 diametral pitch, cutting cast iron.

NILES-BEMENT-POND CO., 111 Broadway, N. Y. List No. 15 of second-hand metal-working machinery. The list includes railroad machinery, screw-cutting lathes, speed lathes, turret lathes and automatic screw machines, planers, shapers, drills, multiple-spindle drills, milling machines and profilers, boring machines, punch presses and shears, grinding and polishing machines, etc.

ROCK ISLAND TOOL CO., Rock Island, Ill. Catalogue of vises made in a large variety of styles. The swivel styles are automatic in action, the vise being locked in whatever position it has when the jaws are tightened. The catalogue also lists plain machinists' vises, pipe vises, tool-stands, etc. It is finely illustrated and altogether a very creditable production.

THEO. ALTENEDER & SONS, Philadelphia, Pa. Catalogue of drawing instruments. Draftsmen who like fine instruments always find Alteneder's catalogue of much interest. The present issue is of the 21st edition. A discount sheet, special offers on 3-inch scales and small opaque-edge transparent triangles are worth the attention of the drafting fraternity.

CHICAGO FLEXIBLE SHAFT CO., 149 La Salle Ave., Chicago, Ill. Catalogue No. 21 of the Stewart gas blast furnaces for various metallurgical purposes. The importance of exact heat control in the hardening and tempering of tools cannot be too strongly emphasized. The gas furnace, properly operated, is probably the most convenient, available means of getting exact results, and as now built it is adaptable to almost every conceivable heating requirement.

STANDARD STEEL WORKS, Philadelphia, Pa. Reprint of paper on steel tires, treating of causes of defects and failures, which was read by Mr. George L. Norris before the Western Railway Club, October 18, 1907. This interesting treatise is well worth the attention of every practical railway man interested in the maintenance of railway rolling stock.

CUTLER HAMMER CLUTCH CO., Milwaukee, Wis., has issued a little booklet entitled "Lifting Magnets and Recent Improvements in Them." This little booklet, which is a reprint from *Cassier's Magazine* for October, 1907, is printed in the form of a miniature magazine. It describes the development of the lifting magnet, and it illustrates the different kinds of magnets used for handling pig iron, metal plates and other classes of material.

HAMILTON MACHINE TOOL CO., Hamilton, Ohio. Bulletins Nos. 1 to 69, inclusive, of lathes, planers, shapers, upright and radial drills. A number of new tools and attachments are described, including a taper attachment for engine lathes, relieving attachment for engine lathes, 42-inch heavy pattern lathe, line of all-geared head lathes, friction-geared heads for "Hamilton" lathes, lathes with double back-gears, variable speed planers, etc.

SIMONDS MFG. CO., 40 Murray St., New York. Brochure entitled "Seventy-five Years of Business Progress and Industrial Advance, 1832-1907." It records in an interesting manner the development of the business which was started in West Fitchburg, Mass., by Abel Simonds in 1832. The growth from this small beginning has been remarkable. Besides the large plant in Fitchburg are the Chicago, Ill., and Montreal, P. Q., plants, and stores in the principal American cities and London.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet on air brake lubrication, containing sixteen pages. It briefly describes the air brake testing rack installed at Purdue University by the Master Car Builders' Association, which has the full air brake equipment of two fifty-car trains. It was on this equipment that Prof. Goss made the tests of Dixon's flake graphite, which demonstrated the value of this lubricant for air brake apparatus. The booklet contains other interesting matter on the lubrication of air brake parts.

LYON METALLIC MFG. CO., Aurora, Ill.' Pamphlet illustrating steel factory equipment installed by the company in the new George N. Pierce Co. plant, Buffalo, N. Y., builder of the well-known automobile "The Great Arrow." The factory equipment consists of box shelving for bolts, nuts, screws, washers, etc., steel and iron bar racks, bins and shelves for castings, racks for tires, frame parts, etc. The manifest advantages of steel factory furnishings are durability, neatness of general appearance and non-inflammability. The latter consideration is one of great importance in all shops. The pamphlet is a fine example of advertising literature.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4559, describing lines of motor starting rheostats and panels for direct current. The rheostats contain an improved enclosed type resistance unit consisting of a low temperature coefficient resistance wire wound on a strong tube that is not brittle. The unit is treated with a special compound which forms a coating both inside and out, making a strong and solid construction, and is thoroughly baked before being placed in the rheostat. Rheostats with no-voltage release and those with both no-voltage and overload release are illustrated and described, as well as rheostats for starting reversible shunt or compound wound constant speed motors. In order to facilitate the installation of motor starting devices, the General Electric Company has perfected a line of motor starting panels in which there is no multiplicity of the terminals to give trouble from bad or incorrect connections.

GENERAL ELECTRIC CO., Schenectady, N. Y., has included low pressure air-compressors rated from 0.88 pound to 4 pounds per square inch and from capacities of 750 to 10,000 cubic feet of free air per minute in its line of centrifugal air-compressors described in MACHINERY, December, 1907, and in G. E. Bulletin No. 4564. These machines are similar to the well-known centrifugal pump in both appearance and operation, and consist of a rotating impeller surrounded by a casing with an intake opening at the center and a discharge opening at the circumference. The efficiency of apparatus of this character depends largely upon the design of the impeller and casing, and the present General Electric practice is based on a series of exhaustive experiments which have been carried out during the past few years. Compressor sets are furnished driven by Curtis steam turbines, direct-current motors and induction motors. Among the industrial applications are mentioned compressors used in foundry cupola service, for gas furnace service where a constant pressure is maintained, and for exhauster service in sulphite pulp mills, chemical works, etc., where a small degree of vacuum is required. They can also be used for the ventilation of deep mine shafts, copper smelting industries, kilns, glass and bottle works and filtration and purification plants. Some of the principal advantages of centrifugal compressors given in the bulletin are low maintenance and repair, high efficiency and economy in operation and floor space.

MANUFACTURERS' NOTES.

SUPERIOR MACHINE TOOL CO., Kokomo, Ind., has added 28-, 32- and 36-inch sizes to its line of upright drill presses, and will also add 25-, 28-, 32- and 36-inch sizes with tapping attachment.

YOUNGSTOWN CAR MFG. CO., Youngstown, Ohio, builder of industrial cars for all purposes, has added Mr. Parker Dodge to its sales force, with temporary quarters at 220 Lewis Building, Pittsburg, Pa.

J. J. MCCABE, for many years at 14 Dey St., New York, has taken offices in the Hudson Terminal Building, and will remove to these quarters as soon as they are ready for occupancy, which will probably be next May.

CHARLES G. SMITH CO., 603-604 Park Building, Pittsburg, Pa., states that the rumor based on its connection with the Pittsburg Emery Wheel Co. to the effect that it is about to discontinue its machine tool business, is not true.

PITTSBURG AUTOMATIC VISE & TOOL CO., Pittsburg, Pa., has been awarded the contract for the complete bench equipment of vises for the Schoen Steel Wheel Co.'s new plant at Newlay, Yorkshire, Eng. The company reports a heavy British trade.

BOSTON GEAR WORKS, Norfolk Downs (near Boston), Mass., announces that the new addition to its factory gives 50 per cent more floor space, making the present total 34,000 square feet. The machine capacity is 150, including about 50 automatics.

AMERICAN TOOL WORKS CO., 300-350 Culvert St., Cincinnati, Ohio, held its annual stockholder's and directors' meeting January 21 and elected the following officers: Franklin Alter, president; J. B. Doan, vice-president and general manager; Robert S. Alter, secretary; and Henry Luers, treasurer.

THE TECHNICAL PUBLICITY ASSOCIATION held a regular meeting in New York, evening of January 30, to discuss the topic, "Mail Order Advertising." The meeting was well attended. For further information regarding the association address Mr. Rodman Gilder, Crocker-Wheeler Co., Ampere, N. J.

GANDY BELTING CO., Baltimore, Md., has won in its action against the Weller Mfg. Co., Chicago, Ill. The U. S. Court for the Northern District of Illinois, East Division, has issued a decree in favor of the plaintiff perpetually restraining the defendant from using the trade-mark of the Gandy Belting Co., or making, selling or advertising stitched cotton belting painted or dyed red in imitation of the Gandy belting.

HESS-BRIGHT MFG. CO., Philadelphia, Pa., has found it necessary to make a third change to larger quarters. It will shortly occupy a four-story building at Twenty-first St. and Fairmount Ave., with a floor space of 15,000 square feet, exclusive of the basement, which latter is given up to a modern construction gas producer plant. The new quarters will be occupied by the company about the middle of March.

IDEAL CONCRETE MACHINERY CO., South Bend, Ind., has deposited an improved cement block machine in the Laboratory for Testing Materials, Purdue University. This machine will be used by students in their study of cement products; and the experts of the laboratory will investigate the possibilities of improving the cement block, a product that has come into such widespread use, and which offers such great advantages as a constructive element.

PATTERSON, GOTTFRIED & HUNTER, LTD., will remove from their building at the corner of Center and Walker Sts., New York, which they have occupied so many years, to make way for the new subway loop ordered by the Public Utilities Commission. They have acquired a six-story building with basement at Nos. 211-215 Center St. and 147-151 Lafayette St., located within a few hundred feet of the present store. The removal will be effected about June 1.

GENERAL ELECTRIC CO., Schenectady, N. Y., has built four factories during the past year at East Boston, Mass; Toledo, Ohio; Fort Wayne, Ind.; and Newark, N. J., to take care of the heavy demand for Edison lamps and the G. E. M., tantalum and tungsten lamp developments. The Toledo factory makes the G. E. M. filament lamps only; the Newark factory is confined to the tungsten lamps; and the East Boston and Fort Wayne factories make carbon filament lamps only. In addition, a new factory adjoining the Harrison, N. J., factory was built to manufacture tungsten lamps. The total productive capacity of all the G. E. lamp factories is 60,000,000 a year.

CUT OUT ON THIS LINE.

PUNCH O PUNCH O

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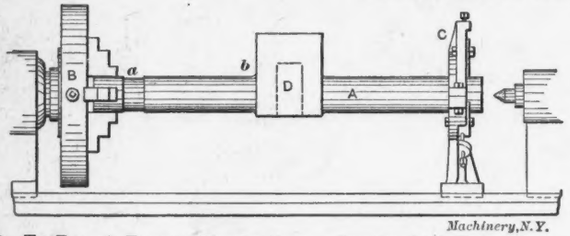
SHOP OPERATION SHEET NO. 55.

Stanley Gould. MACHINERY, March, 1908.



Machinery, N.Y.

To Rough Turn a Single-throw Crank-shaft Forging.

1. Place on the lathe spindle an independent four-jaw chuck *B*. Clamp center-rest *C* to the lathe bed at a point nearly the length of the forging *A* from the chuck.

2. Place the end of forging *A* in the jaws of the chuck *B* and clamp it, supporting the opposite end in the center-rest *C*. Lubricate the inner ends of the jaws. Prick punch center of forging. Adjust center rest jaws to bring this mark opposite tail center. Start the lathe. Hold a piece of chalk against the forging at *a*, and adjust chuck jaws until forging runs true.

3. Turn the space *a* long enough to take center-rest jaws.

4. Reverse the forging *A*, placing opposite end in chuck jaws, and space *a* in center-rest jaws. Adjust the chuck jaws as in Step 2.

5. Face end of forging to length. Drill and ream center. Bring up tail-stock center. Remove center-rest *C*. Turn a bearing for center-rest between chuck and crank, and close up to crank as at *b*, and adjust center-rest here.

6. Rough turn the end next to tail-stock, leaving from 1/16 to 1/8 inch, according to size of shaft, for finishing.

7. Change center-rest *C* to opposite side of crank. Rough turn shaft from crank to chuck.

8. Face both outsides of crank nearly to finish dimensions.

9. Change forging end for end, supporting tail-stock end in center-rest *C* jaws on turned part. Turn part previously held in chuck, face end to length, and drill and ream center. Remove forging from lathe.

10. Lay off that portion of the crank which is to be removed, as shown by the dotted lines at *D*. The vertical dotted lines should be equidistant from the sides of the crank, and the horizontal dotted line located so as to leave plenty of stock for the pin. Lay out rows of holes, inside these dotted lines, spaced so as to touch each other.

11. First drill each alternate hole, and then the remaining holes, the holes being drilled through the forging in both instances. Alternate holes are drilled first to prevent the drill from running into the hole next to it, as it would be apt to do if the holes were drilled in succession. After the holes have been drilled, remove the center piece with a hammer and chisel.

NOTE.—When the crank-shaft is large, the center piece can be removed with less trouble by drilling one row of holes along the horizontal dotted line, and then removing the center piece on the slotter, one cut being taken along each vertical dotted line.

PUNCH O PUNCH O

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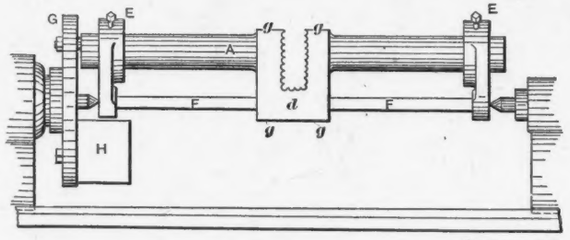
SHOP OPERATION SHEET NO. 56.

Stanley Gould. MACHINERY, March, 1908.



Machinery, N.Y.

To Turn the Crank-pin of a Single-throw Crank-shaft Forging.

NOTE.—The crank-shaft is supposed to have been centered, the ends faced to the required length, and the shaft rough turned.

1. Select a pair of crank dogs or carriers *E* which are bored slightly smaller than the rough-turned shaft. Each of these dogs must be provided with a center upon which the work rotates when turning the crank-pin. The distance from these crank-pin centers to the center of the hole in the dog must equal the throw of the crank. Midway between each crank-pin center and the center of the crank dog hole, there is another center. These intermediate centers are used when turning the ends *g* of the crank.

2. Turn the ends of the shaft to fit the holes in the crank dogs *E*, and then place the dogs on the shaft as shown in the cut, allowing the ends of the shaft to project through the dogs as far as possible to make the work more rigid.

3. Put the crank-shaft in the lathe, using the crank-shaft centers. Locate the center of the crank-pin on one side of the crank. The distance from this center to the shaft will equal the throw of the crank, minus one-half the diameter of the shaft. Place the crank in a horizontal position, with the crank-pin center the same height from the lathe bed as the lathe centers. Measure the distance from the crank-pin center to the lathe bed, and then adjust each crank dog until the distance from the crank-pin center in the dog to the lathe bed is equal to this measurement. Fasten the crank dogs securely in place by tightening their set-screws.

4. Fit braces *F* between the crank dogs and the crank, to take the thrust of the lathe centers, and then shift the crank-shaft in the lathe, supporting it by the crank-pin centers. Move the crank-shaft until its centers are about the same height as the lathe centers, then caliper from the shaft to the lathe bed and see if the shaft is parallel with the bed. If it is not, one of the dogs must be readjusted.

5. Fasten a driver to the face-plate *G*, and a counterbalancing weight *H* opposite the crank-shaft.

6. Rough turn the inside faces of the crank to nearly finish dimensions. Rough turn crank-pin *d* until it is cylindrical.

7. Finish inside faces of crank to dimensions, leaving fillets next to crank-pin. Finish crank-pin to finish dimensions.

8. Put the work on the intermediate centers in crank dogs *E*, and finish the ends *g* of the crank.

PUNCH O PUNCH O

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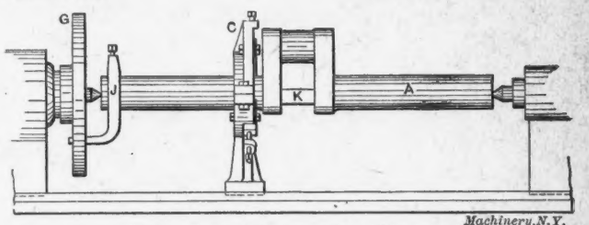
SHOP OPERATION SHEET NO. 57.

Stanley Gould. MACHINERY, March, 1908.



Machinery, N.Y.

To Turn the Main Bearings of a Single-throw Crank-shaft.

NOTE.—It is assumed that the main bearings and the outside faces of the crank have been rough turned, and the inside faces of the crank, and the crank-pin, have been finished. The work is supposed to have been left in the lathe on completion of the last operation, with the crank dogs and the braces, shown in the preceding operation, in place.

1. Remove the work from the lathe. Take off the crank dogs *E* and the braces. Put in place the block *K*, carefully fitted, so as to prevent springing the crank-shaft. Put the lathe dog *J* on the crank-shaft and clamp it. Put the shaft between the lathe centers, and the tail of the lathe dog in the slot in the face-plate *G*.

NOTE.—When turning a crank-shaft, unless it be one of very small size, a counterbalancing weight should be fastened to the face-plate. This weight should be placed on the face-plate near the point indicated in the illustration by the tail of the dog *J*. If the dog *J* fits loosely into the slot in the face-plate, the play should be taken up by inserting a wooden wedge.

2. Turn a space on the crank-shaft between the face-plate and the crank, and near the latter, removing as little stock as possible to true it. Clamp the center-rest *C* at this point, oil the jaws and adjust them.

3. Take a roughing cut over the part of the shaft between the crank and the tail-stock center 1/32 inch larger than the finish diameter. If the shaft runs considerably out of true, take two or more cuts, as may be necessary.

4. Take a finishing cut, using a broad, keen-edged tool and a coarse feed. The width of the tool's cutting edge, and the feed, will depend upon the rigidity of the work. Soda water used on the finishing cut will produce a smooth surface.

5. Take a finishing facing cut on the outside face of the crank, making the side of the crank the required width. As the inside face of the crank has been finished it will be necessary to work from this face.

6. Turn the shaft end for end in the lathe, changing the lathe dog to the opposite end, putting a piece of copper under the set-screw to protect the finished surface. Adjust the center-rest jaws and oil their inner ends.

7. Repeat upon the rough-turned end of the crank-shaft the operations of turning described in steps 4 and 5.

NOTE.—As the stock between the sides of the crank was removed after the shaft was rough-turned, the shaft will very likely run somewhat out of true. Because of this, the turning operation described in step 2 is usually necessary.

PUNCH O PUNCH O

II.—TABLES FOR SHEAR OR MOMENT. MOVING LOADS; TWO WHEELS EQUALLY LOADED.

Contributed by John S. Myers.

Notation: W = total load on wheels. $\frac{1}{2}W$ = load on one wheel. L = length of span. B = wheel base. D = distance from support to point at which moment or shear is required. R = ratio of B to $L = B/L$. $\mathcal{X}$ = ratio of D to $L = D/L$. M = bending moment. S = vertical shear on beam which is also the reaction of the support nearest to the point under consideration. V_m and V_s are variables to be taken from tables.

Table giving values of V_m in formula $M = WLV_m$.

$R=\frac{B}{L}$	Values of $D/L = \mathcal{X}$.												
	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.375	0.40	0.425	0.45	0.475	0.50
0.0	0.0475	0.090	0.1275	0.16	0.1875	0.210	0.2275	0.2344	0.24	0.2442	0.2475	0.2494	0.250
0.1	0.0450	0.085	0.1200	0.15	0.1750	0.195	0.2100	0.2156	0.22	0.2231	0.2250	0.2256	0.225
0.2	0.0425	0.080	0.1125	0.14	0.1625	0.180	0.1925	0.1969	0.20	0.2019	0.2025	0.2019	0.200
0.3	0.0400	0.075	0.1050	0.13	0.1500	0.165	0.1750	0.1781	0.18	0.1806	0.1800	0.1781	0.175
0.4	0.0375	0.070	0.0975	0.12	0.1375	0.150	0.1575	0.1594	0.16	0.1594	0.1575	0.1544	0.150
0.5	0.0350	0.065	0.0900	0.11	0.1250	0.135	0.1400	0.1406	0.14	0.1381	0.1350	0.1306	0.125
0.6	0.0325	0.060	0.0825	0.10	0.1125	0.120	0.1225	0.1219	0.12	0.1222	0.1238	0.1247	0.125
0.7	0.0300	0.055	0.0750	0.09	0.1000	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
0.8	0.0275	0.050	0.0675	0.08	0.0983	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
0.9	0.0250	0.045	0.0638	0.08	0.0983	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
	0.0238	0.045	0.0638	0.08	0.0983	0.105	0.1138	0.1172	0.12	0.1222	0.1238	0.1247	0.125
1 or over	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.625	0.60	0.575	0.550	0.525	0.50
	Values of $D/L = \mathcal{X}$ from other support												

In the above the values enclosed by heavy lines are maximum

Table giving values of V_s in formula $S = WV_s$.

$R=\frac{B}{L}$	Values of $D/L = \mathcal{X}$											$R=\frac{B}{L}$
	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	
0.0	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.0
0.1	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.1
0.2	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.2
0.3	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.3
0.4	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.4
0.5	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.5
0.6	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.275	0.25	0.6
0.7	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.325	0.30	0.275	0.25	0.7
0.8	0.60	0.55	0.50	0.45	0.40	0.375	0.35	0.325	0.30	0.275	0.25	0.8
0.9	0.55	0.50	0.45	0.425	0.40	0.375	0.35	0.325	0.30	0.275	0.25	0.9
	0.50	0.475	0.45	0.425	0.40	0.375	0.35	0.325	0.30	0.275	0.25	
1 or over	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	1 or over
	Values of $D/L = \mathcal{X}$ from other support											

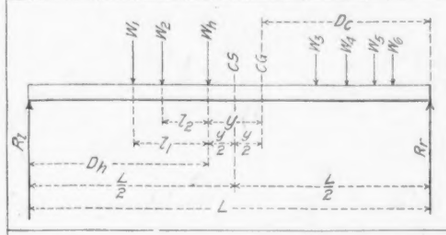
In both the above tables $R = 0$ indicates one wheel instead of two. When $B = 0.5858\,L$ the moment with one wheel in the center of span is equal to the maximum moment with both wheels on.

No. 85, Data Sheet, MACHINERY, March, 1908.

I.—FORMULAS FOR MOVING LOADS.

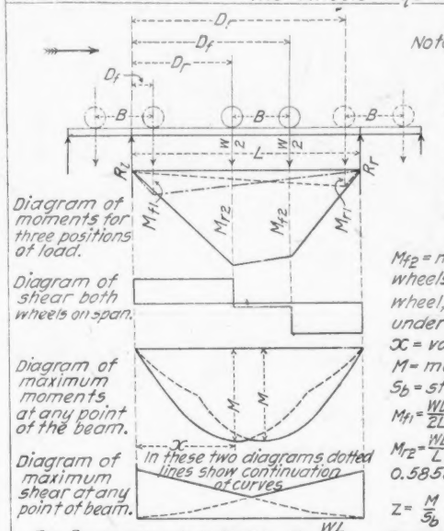
Contributed by John S. Myers.

Location for Maximum Moment.



CS denotes center of span. CG denotes center of gravity of loads. W_h denotes heaviest load adjacent to CG. Let W = total load and M = moment. For M a maximum place CS midway between W_h and CG and find M under W_h. For reactions, $R_l = \frac{WD_c}{L}$ and $R_r = W - R_l$. For maximum moment $M = R_l D_h - (W_1 l_1 + W_2 l_2)$, or since $D_c = D_h$, $M = \frac{WD_c^2}{L} - (W_1 l_1 + W_2 l_2)$.

Two Wheels Equally Loaded.



Notation: All values in inches and pounds. W = total load. $W/2$ = load on one wheel. L = length of span. B = wheel base. R_l = left reaction. R_r = right reaction. V = vertical shear = reaction nearest to the point under consideration. D_f = distance to front wheel, D_r = distance to rear wheel } the load coming on from the left. M_{f1} = moment under front wheel, one wheel on the span. M_{f2} = moment under front wheel with both wheels on the span. M_{r1} = moment under rear wheel, one wheel on the span. M_{r2} = moment under rear wheel, both wheels on the span. $\mathcal{X}$ = value of D_r for M_{r2} a maximum. M = maximum moment. Z = section modulus. S_b = stress due to bending.

$M_{f1} = \frac{WD_f}{2L}(L - D_f)$. $M_{r1} = \frac{WD_r}{2L}(L - D_r)$. $M_{f2} = \frac{W}{L}(D_f - \frac{B}{2})(L - D_f)$.

$M_{r2} = \frac{WD_r}{L}(L - D_r - \frac{B}{2})$ For values of B less than $0.5858\,L$, $\mathcal{X} = \frac{1}{2} - \frac{B}{4}$ and $M = \frac{WL}{4}(1 - \frac{B}{2L})^2$.

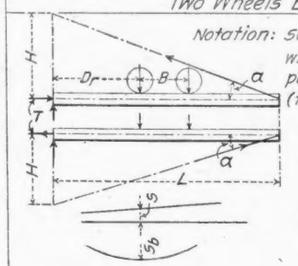
$Z = \frac{M}{S_b}$ or $S_b = \frac{M}{Z}$.

For both wheels on the span, $R_l = \frac{W}{L}(L - D_r - \frac{B}{2})$

For B = or exceeds $0.5858\,L$, $M = \frac{WL}{8}$.

and $R_r = \frac{W}{L}(D_r + \frac{B}{2})$.

Two Wheels Equally Loaded, Oblique Reaction.



Notation: same as above with addition of; a = angle of the reaction with beam. A = cross sectional area of beam. T = thrust or pull due to oblique reaction. S = direct stress due to T (tension or compression).

$T = \frac{W}{H}(D_r + \frac{B}{2})$, or $T = \frac{W}{L}(D_r + \frac{B}{2})\cot a$.

$S = \frac{T}{A} = \frac{W}{HA}(D_r + \frac{B}{2})$, or $S = \frac{W}{LA}(D_r + \frac{B}{2})\cot a$.

M_{f2}, M_{r2}, $\mathcal{X}$, M and S_b = same as above.

$S + S_b = W(\frac{D_r + \frac{1}{2}B}{HA} + \frac{D_r(L - D_r - \frac{1}{2}B)}{LZ})$, or

$S + S_b = \frac{W}{L}(\frac{(D_r + \frac{1}{2}B)\cot a}{A} + \frac{D_r(L - D_r - \frac{1}{2}B)}{Z})$.

$S + S_b$ = a maximum when $D_r = \frac{LZ}{2HA} + \frac{L}{2} - \frac{B}{4}$, $\frac{Z}{A} = \frac{1}{2}L\cot a + \frac{L}{2} - \frac{B}{4}$.

For light weight I-beams $\frac{Z}{A}$ = about $\frac{1}{3}$ depth of beam.

MACHINERY, March, 1908.
Data Sheet No. 85.

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MACHINERY'S DA

Contributions and data suitable for publication in these Data Sheets ar

maximum moment with both wheels on.

$S + S_b$ = a maximum when $D_r = \frac{L}{2HA} + \frac{L}{2} - \frac{B}{4} = \frac{L}{2A}\cot\alpha + \frac{L}{2} - \frac{B}{4}$.

For light weight I-beams $\frac{L}{A}$ = about $\frac{1}{3}$ depth of beam.

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IV.—SAFE STRESS FOR BEAMS UNSUPPORTED LATERALLY.

Contributed by John S. Myers.

In order to provide the same security in both flanges of a beam the compression flange should either be supported against lateral flexure at distances not greater than 20 times the flange width, or a lower stress should be used for the compression flange than is permissible for the tension flange.

The formula given in the Cambria Steel Co's. hand-book corresponding to 16000 lbs. per sq inch safe tensile stress is:

$$S_c = \frac{18000}{1 + \frac{L^2}{3000 b^2}},$$

where the letters have the following values; S_c = safe compressive stress. L = length unsupported in inches. b = breadth of flange in inches.

The curve marked 16000 was plotted according to the above formula.

The curves for 14000, 12500 and 10000 corresponding tensile stresses were plotted from proportionally lower values.

Values of S_c read from the 10000 curve, if considered as a decimal, give the ratio of safe compressive to safe tensile stress.

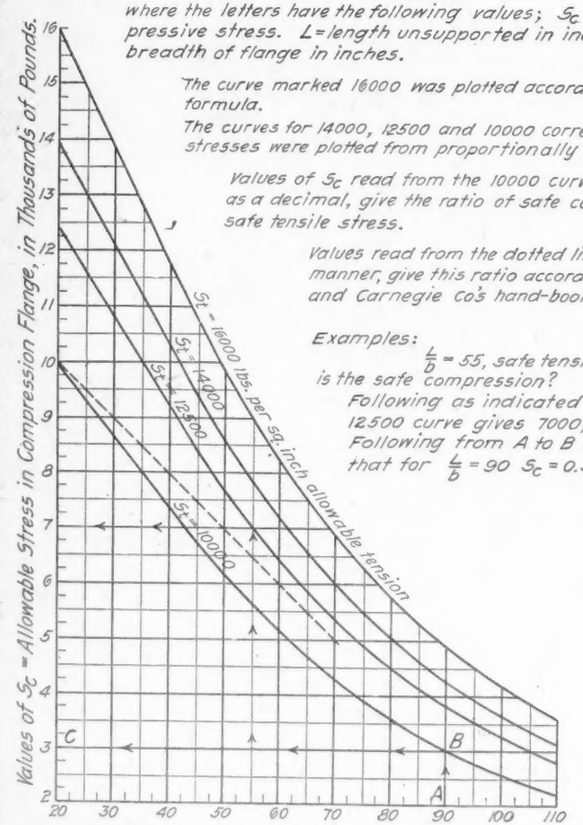
Values read from the dotted line in the same manner, give this ratio according to Pencoyd and Carnegie Co's hand-book.

Examples:

$\frac{L}{b} = 55$, safe tension = 12500. What is the safe compression?

Following as indicated by arrows, the 12500 curve gives 7000; answer.

Following from A to B then to C indicates that for $\frac{L}{b} = 90$ $S_c = 0.3\,S_t$.

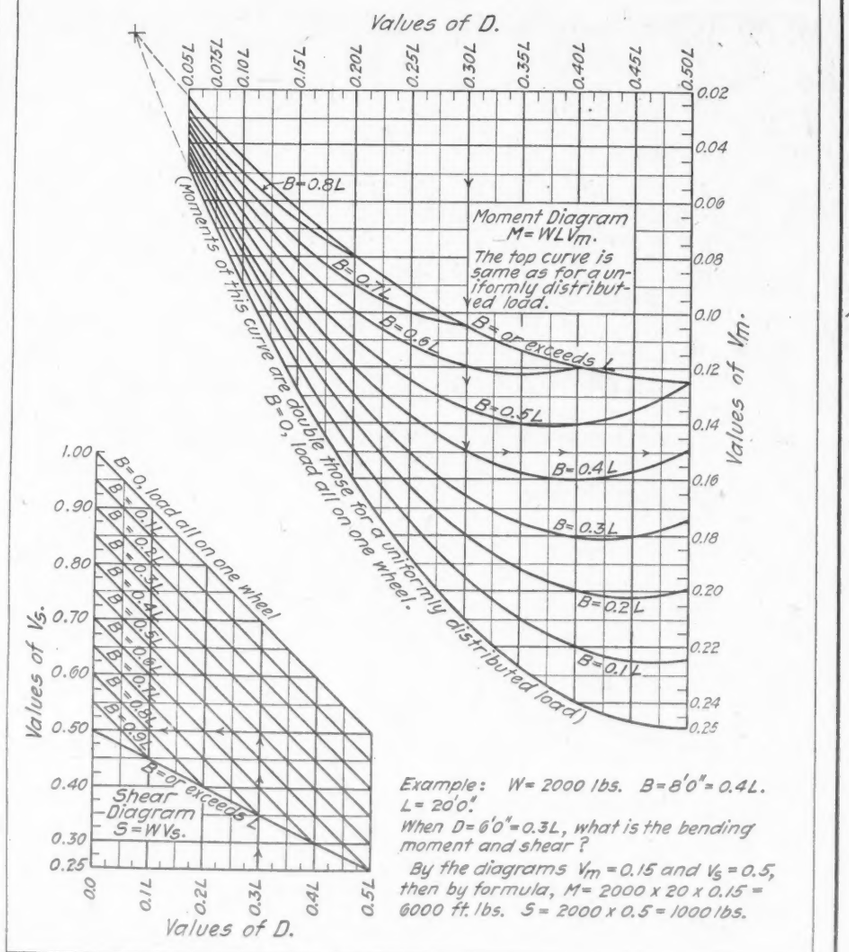

Values of S_c = Allowable Stress in Compression Flange, in Thousands of Pounds.
S_t = 16000 lbs. per sq. inch allowable tension
S_t = 14000
S_t = 12500
S_t = 10000
A
B
C
Ratio of Span to Flange Width = L/b.

No. 85, Data Sheet, MACHINERY, March, 1908.

III.—DIAGRAMS OF MOMENT AND SHEAR. MOVING LOADS; TWO WHEELS EQUALLY LOADED.

Contributed by John S. Myers.

Notation: W = total load $\frac{1}{2}W$ = load on one wheel. B = wheel base. L = length of span. M = bending moment. S = vertical shear. D = distance from nearest support to point where moment or shear is required. V_m and V_s are variables to be taken from the diagrams. The shear is also the reaction at the nearest support.


Values of D.
0.05L 0.075L 0.10L 0.15L 0.20L 0.25L 0.30L 0.35L 0.40L 0.45L 0.50L
B=0.8L
B=0.7L
B=0.6L
B= or exceeds L
B=0.5L
B=0.4L
B=0.3L
B=0.2L
B=0.1L
Moment Diagram $M = WLV_m$.
The top curve is same as for a uniformly distributed load.
(Moments of this curve are double those for a uniformly distributed load B=0, load all on one wheel.)
Values of V_m.
0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.25
Values of V_s.
1.00 0.90 0.80 0.70 0.60 0.50 0.40 0.30 0.25
B=0, load all on one wheel
B=0.1L B=0.2L B=0.3L B=0.4L B=0.5L B=0.6L B=0.7L B=0.8L B=0.9L
B= or exceeds L
Shear Diagram $S = WV_s$.
0.0 0.1L 0.2L 0.3L 0.4L 0.5L
Values of D.

Example: W = 2000 lbs. B = 8'0" = 0.4L. L = 20'0".

When D = 6'0" = 0.3L, what is the bending moment and shear?

By the diagrams V_m = 0.15 and V_s = 0.5, then by formula, M = 2000 x 20 x 0.15 = 6000 ft. lbs. S = 2000 x 0.5 = 1000 lbs.

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MACHINERY'S DATA SHEETS.

Data Sheets are solicited. Payment will be made for all accepted matter.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.